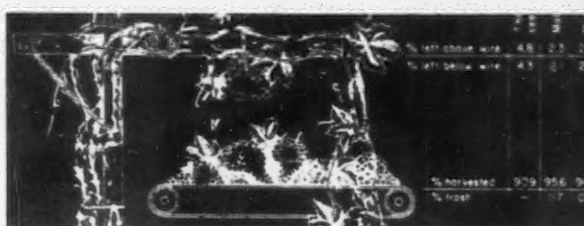
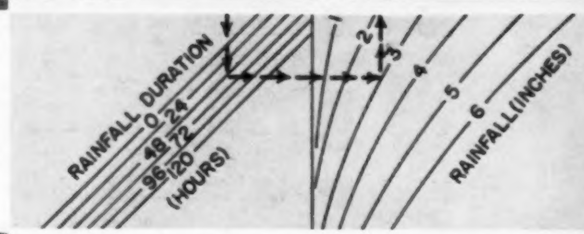
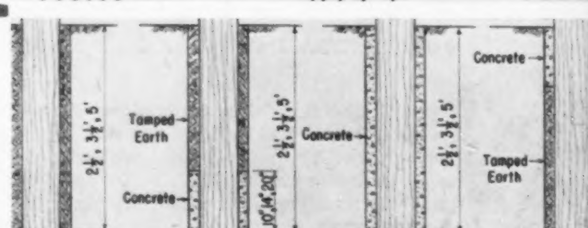
APRIL 1958

Agricultural Engineering

The Journal of the American Society of Agricultural Engineers



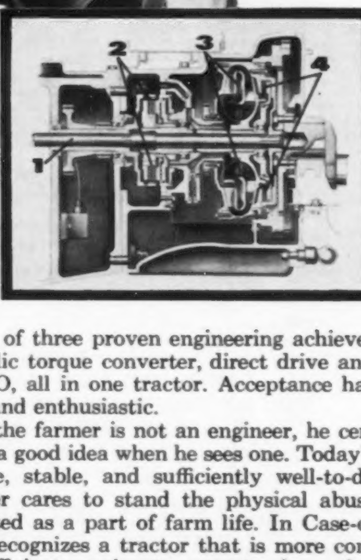




Modern design

from the skin...

to the core



Sectional view of Case-o-matic Drive

1. Independent PTO shaft
2. Multiple Disc Main Powr-Clutch
3. Torque Converter
4. Single Disc Direct Drive Clutch

Is today's farmer design-conscious?

In the six short weeks after Case-o-matic tractors were first introduced, farmers in every state of the Union said, "Yes!"

"I drive a modern car, why not a modern tractor?" they said, time and time again. This is overwhelming evidence that today's modern farmer couples in his mind modern design with efficient performance. But, he insists, efficient appearance is only a good beginning. The promise of efficiency implied in sleek exterior design must be carried out to the very core of the machine.

In Case-o-matic Drive, the farmer has been offered a triple marriage of three proven engineering achievements: a hydraulic torque converter, direct drive and straight-thru PTO, all in one tractor. Acceptance has been immediate and enthusiastic.

For, although the farmer is not an engineer, he certainly recognizes a good idea when he sees one. Today's farmer is mature, stable, and sufficiently well-to-do that he no longer cares to stand the physical abuse previously accepted as a part of farm life. In Case-o-matic Drive he recognizes a tractor that is more convenient, more efficient, easier to operate, less of a compromise . . . a farm tractor much closer to the high mechanical refinement of the modern automobile.

Modern engineering for modern farming is more than just a phrase at Case . . . it is a philosophy . . . a perpetual dissatisfaction with old, outworn concepts . . . a constant seeking of new concepts in power farming—of new approaches to the basic farm problems of producing more for less.

J. I. CASE

J. I. CASE COMPANY • RACINE, WISCONSIN

1st in Quality for Over 100 Years

Agricultural Engineering

Established 1920

CONTENTS • APRIL, 1958 • Vol. 39, No. 4

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JAMES BASSELMAN, *Editor and Publisher*

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For Lack of a Better Measure

To the EDITOR:

THERE has been much publicity lately about a crash program to turn out engineers and scientists wholesale. Particularly distressing has been the suggestion that only those with highest grades should receive attention.

An educator here in Colorado recently made the statement that four-fifths of all students in colleges and universities should be sent home because of low grades and general attitude regarding higher education.

Certainly no one values engineering education more highly than do I. I doubt, however, that the speed up in the education of engineers and scientists will have the effect of putting us on top of the heap in technological advances.

The type of engineers and scientists needed are those with vision as well as technical ability. There is much to be said about improving the quality of students leaving our colleges and universities. Original thinking and planning for future technical developments is engendered in the student's mind partly through his inherent ability and partly through counciling with mature faculty members who themselves are original thinkers. I wonder if a program of better pay for faculty members and more time given to the individual student would not partially answer our present needs.

During my years in charge of a variety of state and government programs, I employed and trained several hundred engineers. In this program I soon learned that the top one-third of the graduating class did not contain all the valuable men by any means. Often men in the lower brackets of scholastical attainment were chosen because in addition to engineering subjects they took some work in the cultural and humanitarian field and could speak, write and spell.

During the time of my presidency of ASAE, I was once in conference with the president and dean of agriculture of a large university. We were discussing the idea of allowing only students with the highest grades to enter college. It was soon discovered that none of the three of us would have ever gotten a college education if this rule had been enforced in our day. The reader might ask himself how he would have fared.

IVAN D. WOOD

2500 Leyden St., Denver 7, Colo.

★ ★ ★

Editor's Note:

The above letter merits special attention, we believe, as an indication of the limitations of scholastic grades for measuring the potential of a young engineer or a candidate for engineering training. There may have been some improvements in grading systems and practices since Ivan Wood was an undergraduate. However, we doubt that many people believe academic grades measure engineering potential with micrometer accuracy. It seems they are being used, to excess, for the lack of some simple better measure.

Dr. Wood's letter suggests that a well-balanced curriculum is a factor in developing engineering potential. Possibly a curriculum value and aptitude test scores could be combined with academic grades to give a composite and more accurate measure of capacity for individual development and useful service in engineering.

These are times when we should be especially careful not to deny agricultural engineering training to "the likes of Ivan Wood," on the excuse that as engineers we have only a poor measuring system for human capacity.

For more facts circle No. 40 on reply card

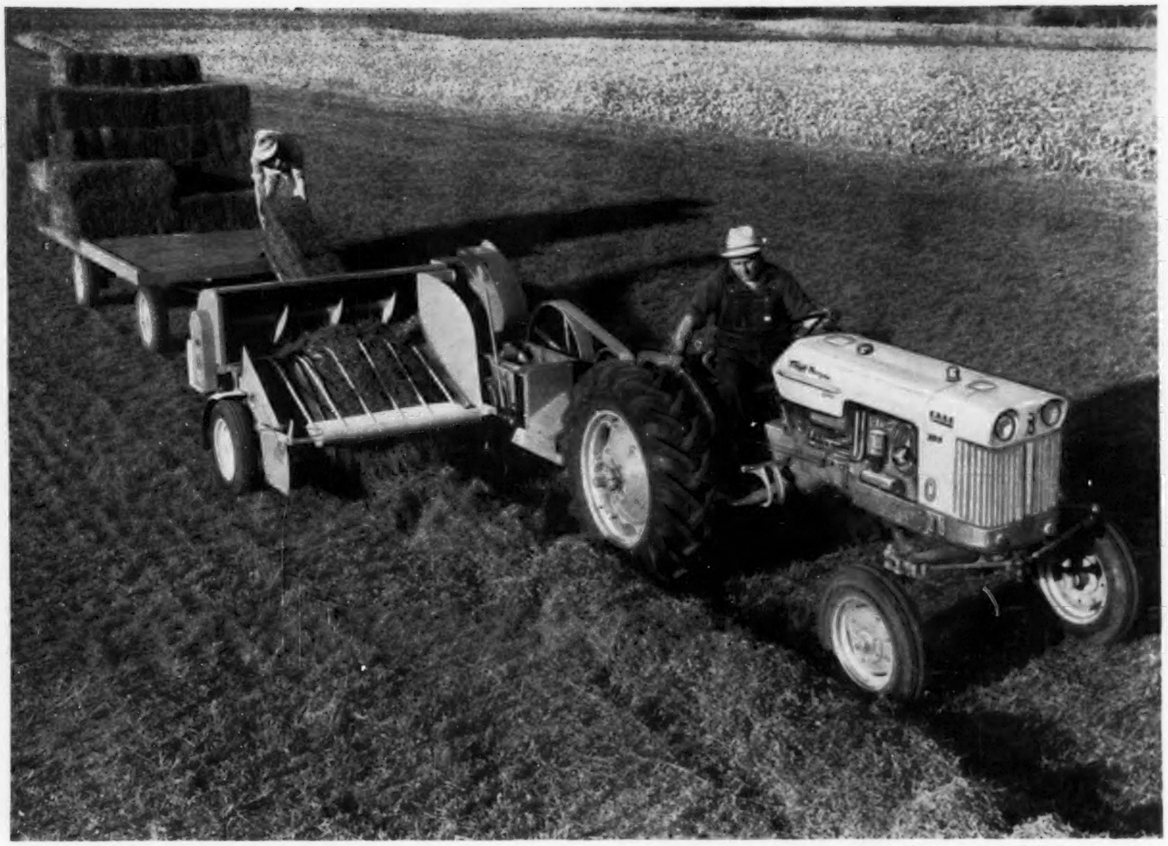

Photo courtesy J. I. Case Company

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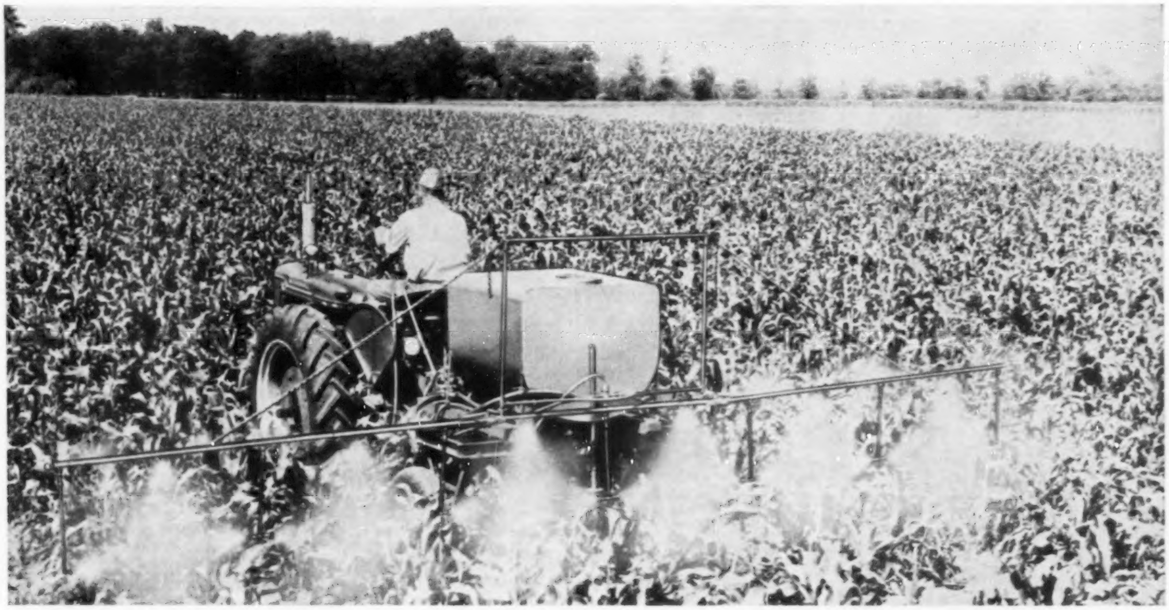


Here's an all-purpose sprayer with stainless steel tank, agitator, and fittings. It can be adapted to spray row crops, orchards, brush, livestock, and many other spraying jobs.

Why it Pays

to Design Stainless Steel into Your Chemical Applicators

Every year, farmers are using more chemicals in liquid form, increasing the need for dependable, more durable applicators. To meet this need, many manufacturers of sprayers design stainless steel into all parts that come in contact with chemicals.

Here's why:

1. Stainless steel is resistant to a wide range of chemicals, permitting the design of equipment for "all-purpose" use.

2. It's easy to fabricate . . . can usually be adapted to current production techniques.

3. Stainless steel is strong . . . stands up under rugged farm use.

4. It's solid metal; there's no coating to damage or peel off in service.

5. No extra thickness needed to compensate for corrosion.

6. Wide range of grades to meet service and fabricating requirements. These include parts suited for machining, welding, and resistance to abrasion as well as corrosion.

Write now

For complete information on Armco Stainless Steel, write us at the address below. If you would like help with specific design problems, our engineers will gladly consult with you.

ARMCO STEEL

ARMCO STEEL CORPORATION, 1678 CURTIS STREET, MIDDLETOWN, OHIO

SHEFFIELD DIVISION · ARMCO DRAINAGE & METAL PRODUCTS, INC. · THE ARMCO INTERNATIONAL CORPORATION

For more facts circle No. 44 on reply card

Report to Readers . . .

NEW MAN-MADE RUBBER EQUALS NATURAL PRODUCT FOR TIRES

A team of scientists set up four years ago under a jointly sponsored rubber-chemicals industry project has just announced the successful testing of a new man-made rubber that equals or surpasses natural rubber for use in tires of all types. In fact, these scientists state that the new material is the answer to the urgent need for a product that will replace natural rubber. . . . . It has also been revealed by this group of scientists that the new man-made rubber has the same molecular structure as tree rubber. This means that the new material can be used interchangeably with natural rubber for making on-the-road or off-the-road tires to meet any high-speed, heavy-duty requirements. Commercially important also is the fact that this new man-made rubber processes the same, vulcanizes the same, is reinforced by carbon black in the same manner, and gives cured properties almost identical to those obtained with tree rubber. . . . . A significant facet of this development is that its timeliness is underscored by the fact that the rubber plantation industry will be unable to meet the rising world demand for natural rubber within the next three to six years.

FARMERS NOW LOOKING OVER RESEARCHERS' SHOULDERS

The USDA Agricultural Research Service reports that there has been a great change in the attitude of farm people and others who use the results of their research. It is not many years ago that farmers were not specially interested in research recommendations, and many researchers really had to beat the drums to get a new crop variety or an improved farming method adopted. But times have changed and now farmers are eager to try new things; in fact, they often look impatiently over the researchers' shoulders, says the ARS. . . . . That's all to the good, and, if that impatience continues to grow, farmers may indeed start breathing down the necks of their congressmen and demanding more funds for a greatly expanded program of engineering research so much needed to help correct the unfavorable economic position of farmers in relation to the general economy.

NEW PRODUCTION PROCESS GIVES HOSE DIMENSIONAL STABILITY

In what it refers to as a significant breakthrough in hose design, one of the rubber companies announces a new manufacturing process it has developed as the first major change in hose building in over 50 years. . . . . The important advantage claimed for the new hose is dimensional stability. Unlike conventional braided hose, which may shorten as much as 18 percent under pressure, the new hose remains constant in length. Also, the danger of this hose pulling out of its couplings is eliminated. It is expected that the greatest use for this hose will be in hydraulic and air systems where dimensional stability is essential for proper functioning of such equipment.

TIME IS OF THE ESSENCE IN DRYING THE HAY CROP

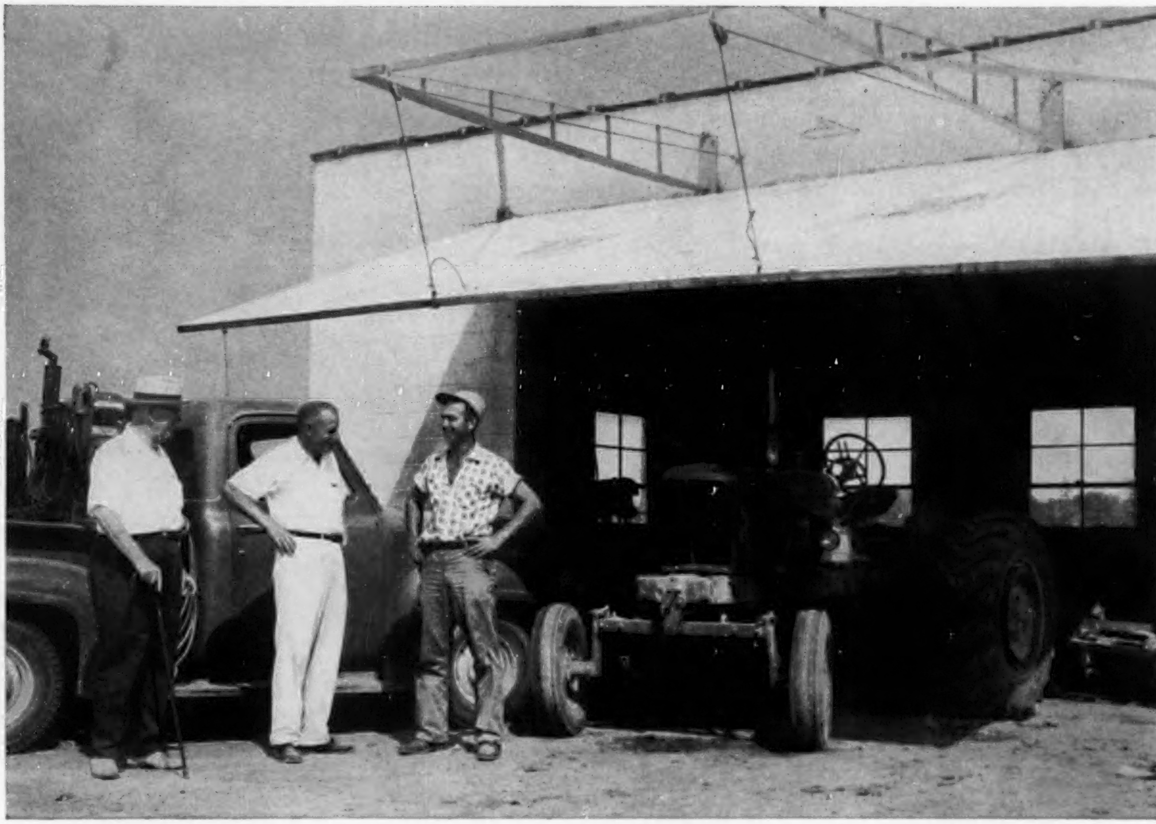
That statement is axiomatic to all who know what it takes to produce top-quality hay, but it has been the engineers who have so far made the major contribution toward solving this age-old problem. . . . . Engineers of the agricultural engineering department of the University of Minnesota, from tests conducted last season, report that hay dried consistently faster after being conditioned, that is, passed through either a crushing or a crimping mechanism - in one instance 16 percent faster after 26 hours of natural drying in clear weather. Another advantage of conditioning is that the stems dry nearly as fast as the leaves, thereby helping to produce hay of higher quality.

FIELD PELLETING OF FORAGE - A NEW DEVELOPMENT TO WATCH Engineers in the agricultural engineering department of the University of Wisconsin, with many years of research background in the handling and processing of forage crops for livestock, have recently come up with a brand new development idea that will be interesting to watch as it unfolds in their research program. This new idea envisions a machine, not yet on the drawing boards, specially designed for the field pelleting of forage, either in the long or chopped form. Experimental work has proven, say the Wisconsin engineers, that alfalfa and grass can be readily compressed into pellets 2 to 5 inches in diameter, which will hold their shape for a moderate amount of handling. Also, dairy cows like the pellets. . . . . The development of field pelleting may come faster than now seems likely, especially in light of the rapid trend toward mechanization of farm materials handling in general, for as the Wisconsin engineers contend, the handling of pellets has several advantages over other methods of forage handling.

GREEN-CHOP FEEDING VS. GRAZING FOR DAIRY COWS Largely because of its machinery and buildings implications, engineers have a definite interest in a cooperative research study by the USDA (ARS) and the Pennsylvania agricultural experiment station on green-chop feeding versus grazing on a typical dairy farm. Early results indicate the former may be more profitable, since grassland feed is used more efficiently when green-chopped. . . . . Since a field chopper is used to convert the grass crop into feed, the hourly overhead on it is reduced when it is used daily to produce green-chop feed, instead of only a few days in the year to make silage. The cost of special equipment for green-chop feeding is considerably offset by less travel time in taking cows to and from pasture, less need of fencing, and elimination of watering systems in distant pastures. Also, the researchers say, cows trample and waste up to 40 percent of the feed while grazing on lush growths.

LIVESTOCK DRINKING BOWL A MIRACLE OF SIMPLICITY Sometimes out of a design problem there will evolve a solution that is almost astounding in its simplicity. A good example is that of a livestock drinking bowl developed by a company in England. The bowl is so pivoted that, when it becomes filled with water, it swings one way pinching the rubber inlet tube and cutting off the supply. Then as the bowl empties, it swings the other way and allows the water to flow into it again.

NEW AND SAFER EXPLOSIVE AGENT CUTS DEEP INTO BLASTING COSTS A new explosive that is safe, easy to handle and effective consists of a simple mixture of fertilizer-grade ammonium nitrate and fuel oil. So reports "Construction Methods and Equipment," a McGraw-Hill publication. . . . . In some cases, it is reported, this blasting agent has cut powder costs for surface blasting by as much as 75 percent. Ammonium nitrate, however, has some drawbacks as an explosive agent. For one thing, it cannot be used in a wet hole. Also, it is more difficult to detonate than dynamite. But when conditions are right, it can be a real money saver where there is a considerable amount of surface blasting to be done. . . . . There is one real danger, however, in the use of ammonium nitrate as a blasting agent: it is so safe to handle that workers tend to get careless and forget that any explosive is unpredictable to some degree.



HOMEMADE DOOR DOUBLES HIS SHOP AREA

THIS over-sized door, easily operated with a hand winch, is the invention of John Van Kesteren, Jr., Onancock, Va. It practically doubles his shop-working area, providing shelter from sun and rain. Left to right are Texaco Distributor H. C. Watson, Mr. Van Kesteren, and Foreman L. E. Crockett.

For more than 20 years, Distributor Watson has supplied Texaco products used for the farm machinery in the Van Kesteren 800-acre operation. As a successful, large-scale operator, Mr. Van Kesteren, like leading farmers in every state, has found *it pays to farm with Texaco products*...and that Texaco Fire Chief gasoline delivers superior fire power for low-cost operation.

IT'S MARFAK FOR HIM! B. E. Roebuck (left), of Harrison Oil Co., tells H. B. Winslow, of Williamston, N. C., Texaco Marfak lubricant is best because it won't drip out, wash out, dry out or cake up. Marfak-lubricated bearings can take it!

35-YEAR TEXACO USER! Texaco Consignee H. H. Shapard (right), has supplied Texaco products since 1923 to L. E. Ragland, of Halifax, Va. Mr. Ragland finds that Havoline Motor Oil wear-proofs truck and tractor engines, prolongs the life of machinery.

IN ALL 48 STATES – you'll find Texaco Dealers with top-octane Texaco Sky Chief Su-preme gasoline, supercharged with Petrox, for maximum power... and famous Texaco Fire Chief gasoline at *regular* price, Havoline Motor Oil and Marfak lubricant.

On farm and highway it pays to use

TEXACO PRODUCTS

Texaco Products are also distributed in Canada, Latin America, and Africa.

THE TEXAS COMPANY

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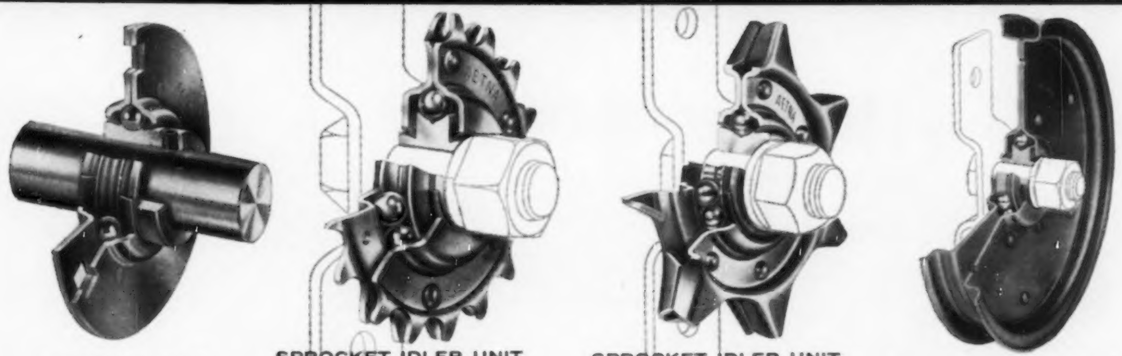
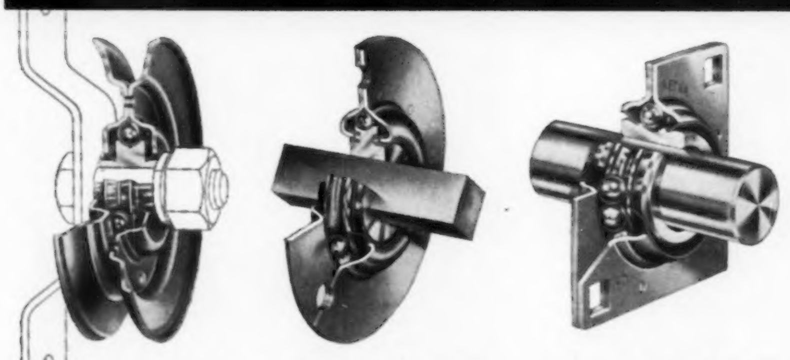
AMERICA'S MOST COMPLETE LINE



ADAPTER UNIT — SPROCKET IDLER UNIT (Single pitch chain type) — SPROCKET IDLER UNIT (Detachable link chain type) — FLAT BELT IDLER UNIT

OF LOW-COST, PRE-LUBRICATED



V-BELT IDLER UNIT — DISC HARROW UNIT — GRAIN ELEVATOR UNIT

The Economy Line That Lets You Put MORE Ball Bearing Efficiency to Work in MORE Places

BALL BEARING *Package* UNITS

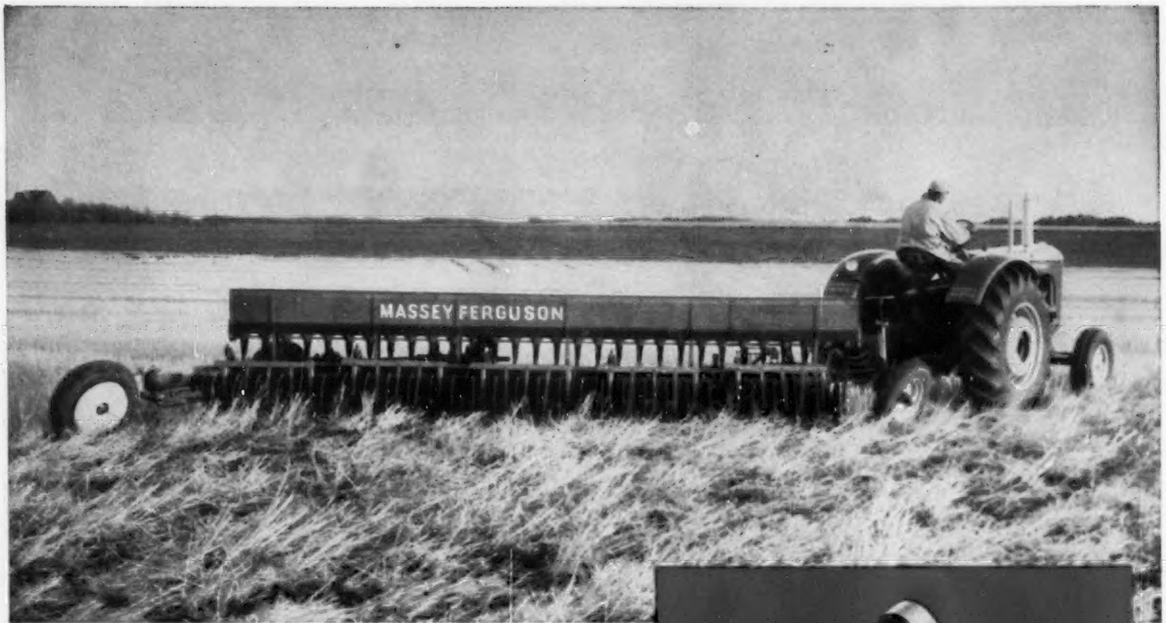
Designed and built-to-be-installed-and-forgotten these permanently lubricated, sealed-for-life bearing units require no re-lubrication, no maintenance of any kind. Factory assembled, they combine bearing, seals and housing in a single, compact, easy-to-install *package* that saves time on equipment assembly lines—assure longer, trouble-free performance to equipment users.

Catalog AG-57 gives complete specifications. Write for it on your company letterhead—see how, with minimum or no engineering alterations, these inexpensive bearing units can be adapted to your current or projected equipment designs. Aetna Ball and Roller Bearing Company, Division of Parkersburg-Aetna Corporation, 4600 Schubert Avenue, Chicago 39, Illinois.

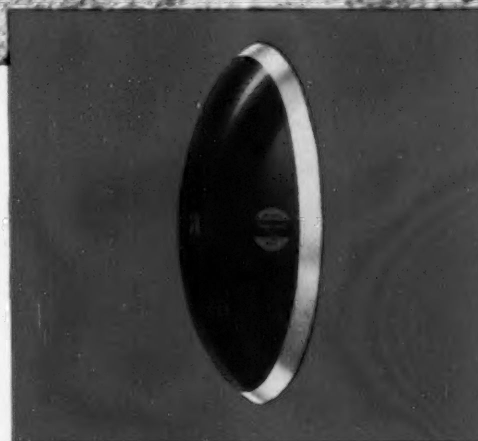
Aetna

Anti-Friction Consultant to Leading Original Equipment Manufacturers Since 1916

For more facts circle No. 46 on reply card



Breaking up wheat stubble with a Massey-Ferguson wide level disc harrow equipped with Ingersoll discs



RUGGED and RELIABLE right down to the Ingersoll Discs

Farm operators like the rugged dependability of these two Massey-Ferguson implements. They're engineered for outstanding performance and built to do the toughest jobs.

Notice the discs. They're Ingersolls. And they're every bit as rugged and reliable as the equipment. They're sharp and they stay that way because they have greater resistance to abrasion. They can take rough field shocks without splitting or curling because they're made of TEM-CROSS® steel—Ingersoll's extra tough tillage steel that's *cross-rolled* for greater strength.

Like Massey-Harris-Ferguson, *all* leading farm implement manufacturers use Ingersoll discs as original equipment. That way they're sure of delivering top quality—from the ground up.

It's good business to sell Ingersoll discs whenever you make replacements. You can order them direct from your implement manufacturer, and you'll find it's a sure way to customer satisfaction.

Ingersoll discs on this Massey-Ferguson wheeled tandem disc harrow make short work of preparing seed beds.

INGERSOLL PRODUCTS DIVISION
Borg-Warner Corporation, Chicago 43, Illinois

B-W ®

SPECIALISTS IN TILLAGE STEELS • WORLD'S LARGEST MANUFACTURER OF DISCS

EXPORT SALES: Borg-Warner International, 36 S. Wabash, Chicago 3, Illinois

THE ONLY MANUFACTURER OF DURA-DISC — THE STEEL THAT IS THE ECONOMICAL REPLACEMENT FOR HIGH COST ALLOYS

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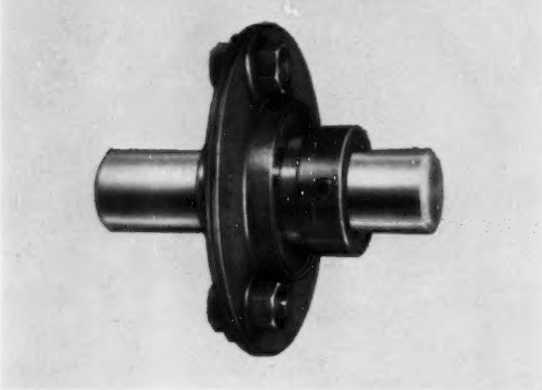
SHAPED TO FIT YOUR NEEDS!

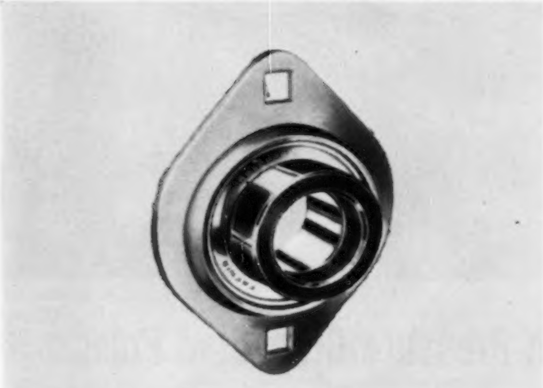
Cost-wise... Design-wise

Three- and Four-Bolt Flangettes

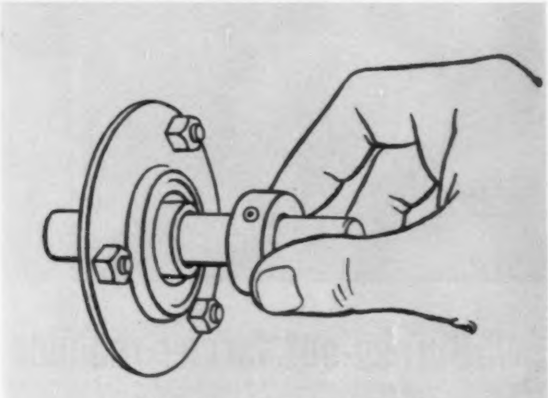


Triangular Flangette

FAFNIR FLANGETTE FAMILY



Two-Bolt Flangette



Fafnir-originated Self-Locking Collar

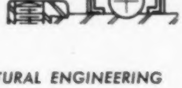
The original Flangette, introduced over a decade ago by Fafnir, offered for the first time the cost-cutting advantages of a "packaged", ready-to-mount ball bearing unit—complete with self-contained housing, prelubricated bearing, and integral seals.

Today's "Family of Fafnir Flangettes" meets various *design* needs as well. In addition to the widely popular three- and four-bolt Flangettes, two-bolt and triangular types are now available. They were developed expressly for installation where mounting space is limited.

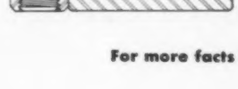
Slinger-type Mechani-Seals or, for slower speeds, contact-type Plya-Seals protect against contaminants and loss of lubricant. Wide inner ring or extended inner ring ball bearings may be specified. Both type bearings feature the Fafnir-originated self-locking collar that secures bearing to shaft with a twist of the wrist.

For full details on these low-cost answers to antifriction design problems, write The Fafnir Bearing Company, New Britain, Connecticut.

Extended Inner Ring Ball Bearing with Plya-Seals — RA Series



Wide Inner Ring Ball Bearing with Mechani-Seals — LL Series



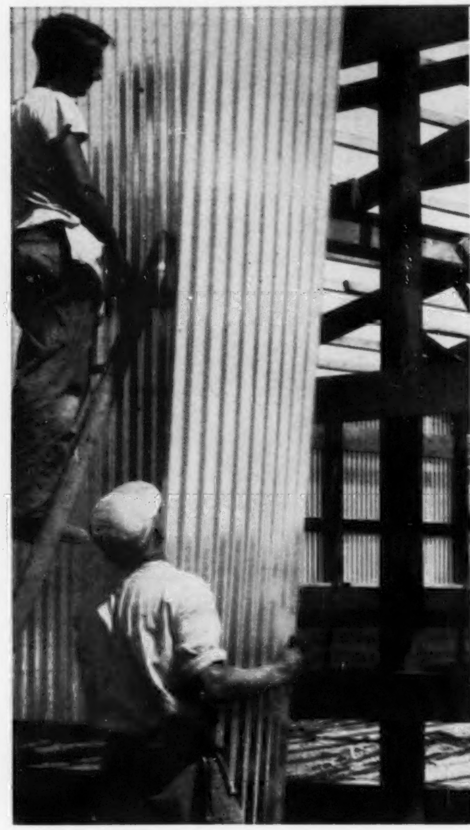
Wide Inner Ring Ball Bearing with Plya-Seals — RR Series

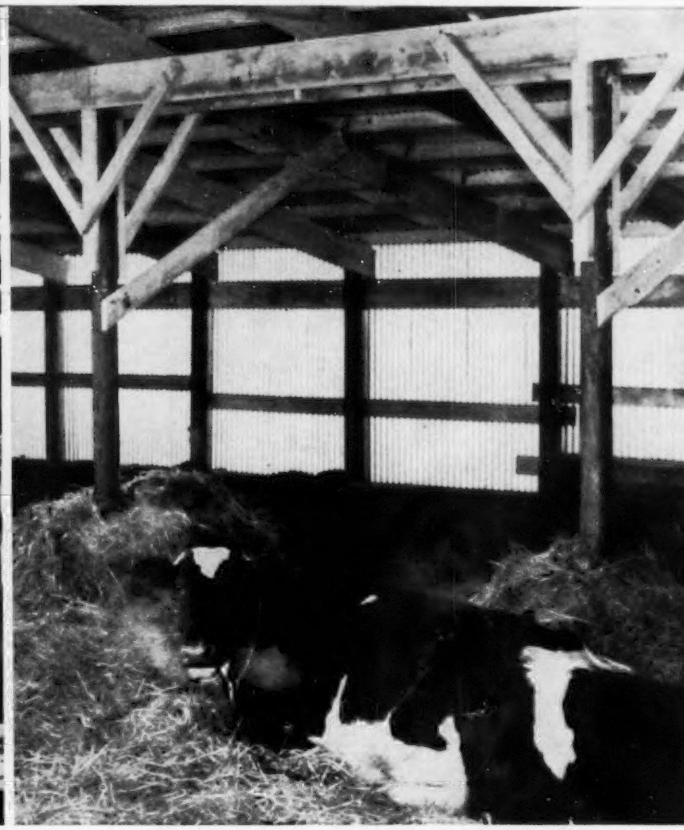
FAFNIR
BALL BEARINGS

For more facts circle No. 48 on reply card

USS Steel Roofing and Siding is low in cost, goes on quickly, provides protection against storms, fire and lightning.

Loafing barn: 45 x 130 feet, built with Pressure-Creosoted Poles and USS Galvanized Steel Roofing and Siding. Open on the south side for light and sun. Hay is stored against the north wall.





Burned-out farmer rebuilds with Pressure-Creosoted Poles

Selects the loose housing system for high efficiency

When Adolph Engelbrecht, dairyman of Munnsville, New York, lost two barns and a crop of hay in a fire last July, he decided to investigate every new idea in dairy management and build the most efficient housing system possible.

After weighing the pros and cons of several methods, he chose the loose housing system. His new set-up included a pole-constructed feed barn, a box silo, a loafing barn, a paved barnyard and the new time-saving "herringbone-type" milking parlor.

The pole-type construction with Pressure-Creosoted Poles met the need for durability and quick erection of buildings. There were no foundations to pour—once the holes were dug, the poles were set and quickly aligned and braced. Rafters, roof purlins and USS Galvanized Steel Roofing and Siding went on in a matter of hours. The Engelbrecht dairy today is one of the most efficient in the area.

Why not start your own program of improvement today? All materials used on this job are available from local dealers.

Agriculture Extension, Room 2831, United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania. *USS is a registered trademark*

NOTE: *U. S. Steel does not pressure-creosote poles, but supplies much of the creosote used by the wood treating industry for this purpose.*

Sales offices in Pittsburgh, New York, Chicago, Salt Lake City and Fairfield, Alabama

USS Creosote

RB&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By John S. Davey

Select proper bolt diameter

An erroneous rule of thumb worth forgetting is that no bolt under ⅝" should be used where fastened members are under stress. Yet bolts ½-inch and smaller take plenty of external loading.

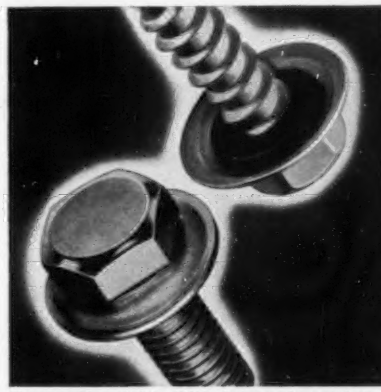
HOW TO LOOK AT IT

Primarily, you have to satisfy the stress requirements . . . the load. So select bolts on that same basis: the actual strength to sustain that load.

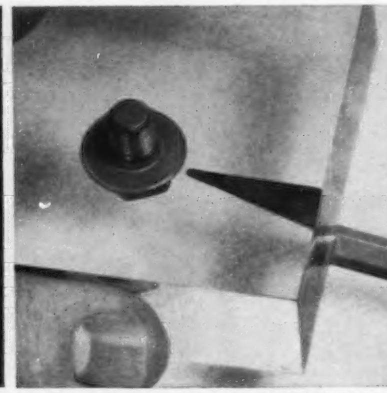
Calculating the strength requirements will tell you what bolt tensile, size, and number you need. If smaller bolts suffice, use them to avoid the penalty of overdesign. Holes can be smaller which means faster drilling and tapping. You have a chance to save materials since with smaller bolt holes, fastened members can often be made smaller too. You may also be able to standardize on a single size, saving assembly-line time.

SIZE VS. SAFETY

Remember that for a given grade of material, size tells you *capacity* of a bolt, not its *safety*. If you *tighten* a bolt to capacity, then you get safety. That's why a smaller bolt properly tightened is better and safer than a larger bolt sloppily tightened, especially where the loads are dynamic. Obviously, you reduce risk of under-torqued bolts as you reduce their size.



The new RB&W "SPIN SEAL" fasteners have spring-type washer with adhering flow-in seal . . . pre-assembled to standard machine or tapping screw.



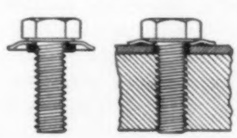
Flow-in sealant is confined by washer. Note how seal fills space under head and flows around and into threads in tightened SPIN-SEAL screw.

New SPIN-SEAL* screws give leakproof fastening

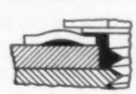
Here is a new type of composite fastener that seals by means of a unique flow-in sealant and washer.

ASSURES TRIPLE SEAL

Concave in shape, the heat treated springy washer confines and controls the flow of sealing compound. Tightening the screw forces sealant into various spaces around (1)



When screw is tightened the compound seals clearance hole and top thread; between washer and surface; between head and washer.



threads, (2) head and (3) clearance hole to give hermetic sealing.

The washer has ability to conform to curved surfaces and still seal securely against hydrostatic pressures and wind driven water. Its spring tension and flat rim give the added advantage of dynamic metal to metal seal.

ONLY THE SCREW TURNS

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Send for Bulletin SS-1 which gives details on RB&W "SPIN-SEAL" fasteners. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.

*T.M.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

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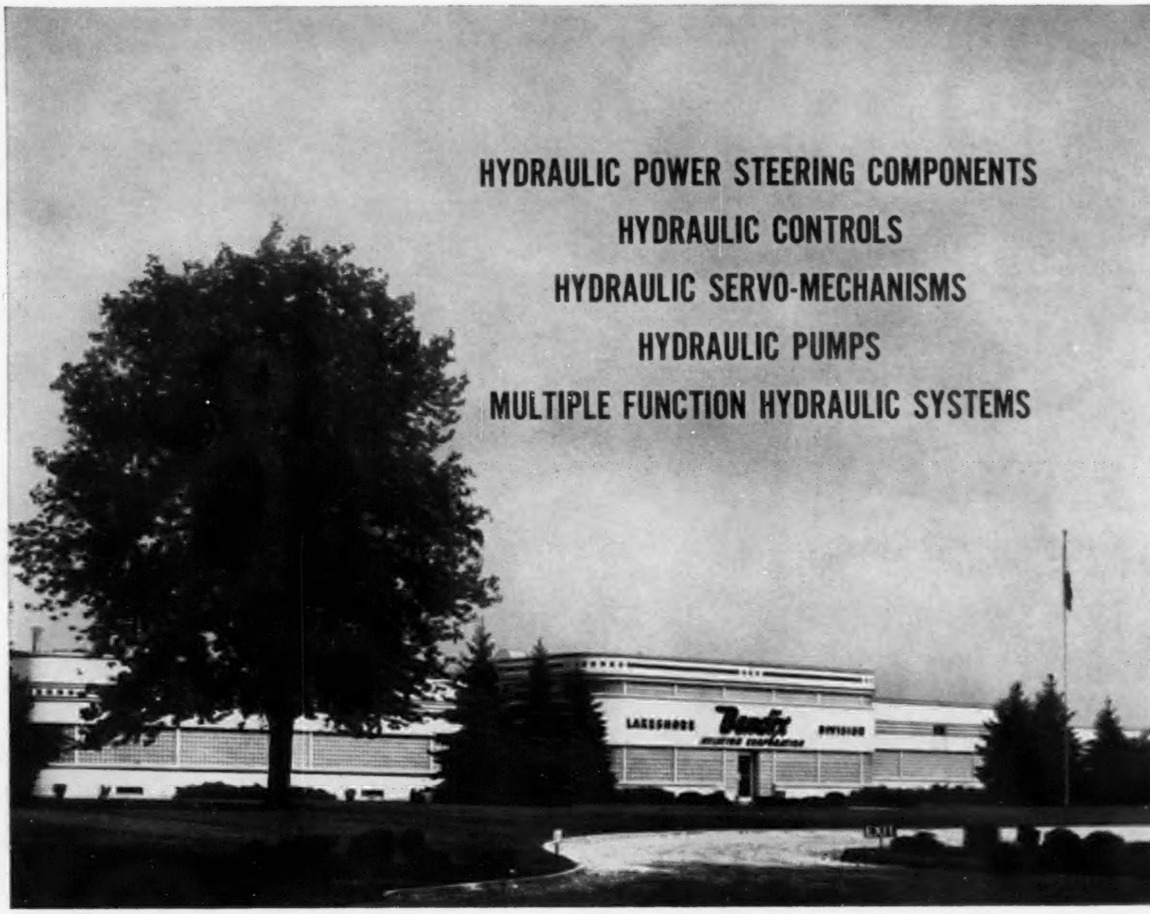

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Agricultural Engineering

April, 1958
Number 4
Volume 39

James Basselman, *Editor*

Maximum Utilization of Technical Manpower

Technical Manpower Waste . . .

THAT the United States has now the engineers and scientists necessary to accomplish the immediate task before us and that we need only to develop and implement policies and plans to properly administer their talents were beliefs advanced recently in a letter to Dr. James R. Killian, Jr., the President's Special Assistant for Science and Technology, by H. A. Meyerhoff, executive director, Scientific Manpower Commission and G. E. Arnold, chairman, Engineering Manpower Commission of Engineers Joint Council. The letter supports a short-range program for reducing manpower waste as a solution to the recently publicized technical manpower issues and related educational problems. It states that even though industrial utilization of technical personnel has improved during the past few years, another great manpower waste results from what is described as substantially outmoded military manpower procurement policies. Although it is conceded that the military should have in the uniformed services all the engineers and scientists needed as such, it is the opinion of the Engineering Manpower Commission that our country cannot continue to waste engineering and scientific talents on non-technical duties.

As a beginning in remedying this situation, E.M.C. offers the following recommendations:

"1 The suspension of induction for military service of engineers and scientists and certain other groups having critical occupations. All things considered, it is our conviction that to expect the military to achieve a satisfactory level of utilization for engineers and scientists in an enlisted capacity places too great a burden on military personnel administrative process.

"2 The release from the military of engineers and scientists not being utilized in their professional capacities, if they request such release.

"3 The revision of ROTC assignment procedure to give priority for brief active duty training periods to engineering and scientific graduates after selections have been made to meet the military needs for technical billets and overriding non-technical military specialties. It is anticipated that the release of enlisted engineers and scientists might increase military needs for ROTC graduates in technical billets. This, we believe, is all to the good.

"4 Review of military retirement procedures to insure that the technical competence of experienced but relatively youthful officers is not lost to the military through premature and forced retirement in accordance with regulations having little pertinence to current and future Armed Forces technical requirements.

"5 The development of a truly Professional Service for career engineers and scientists in the uniformed military services."

Teacher Recruitment Urged

A PLAN to increase the number of young teachers for engineering schools of the United States has been presented also to Dr. James R. Killian, Jr., by The American Society for Engineering Education.

To encourage more good students to enter graduate study, the period during which most engineering students discover their interest in a teaching career, the ASEE states that basic research in engineering must be expanded and that federal agencies supporting basic research in engineering should greatly enlarge both the number and the amount of the grants. The increased amounts adequately should cover the true costs, including the portion of the faculty salaries required to direct the projects. The contracts also should be for longer periods of time, such as five years, and should provide means for the construction or enlargement of the buildings required.

With this as a fundamental premise, the four-point plan is:

1 A substantial increase in the number of National Science Foundation fellowships for first-year graduate study in engineering.

2 A program of secondary grants to those who fail to qualify for full fellowships under the National Science Foundation program.

3 Supplementary federal grants to holders of National Science Foundation fellowships who take part-time teaching assignments.

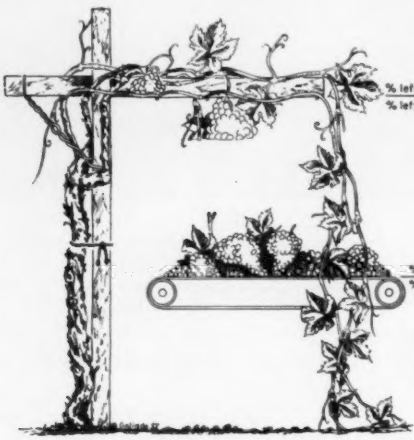
4 A new program of awards under the National Science Foundation to increase the financial aid to graduate students who combine teaching with their education and research experience.

ASEE calls particular attention to the important role of basic research in preparing engineering teachers. Federal support of basic research, the Society's report states, "will determine the supply of individuals with the requisite background to educate engineers in an age when basic understanding of scientific principles must replace dependence on intuition and experience."

Until very substantial steps are taken to relieve the critical shortage of teachers, efforts to increase undergraduate enrollments are "highly questionable," says ASEE's Committee on the Development of Engineering Faculties.

Already, the Committee says, the United States faces a shortage of nearly 1000 engineering teachers. About 9,500 new teachers will be required by 1966.

ASAE 51st Annual Meeting • Santa Barbara Campus, University of California, June 22-25



	SAW CHAIN		RECIPROCATING CUTTER		
	Thompson seedless	Malaga	Malaga	Mission	Aramon & J-711
% left above wire	4.8	2.3	2.8	5.4	1.9
% left below wire	4.3	2.1	2.9	11.2	5.3
% harvested	90.9	95.6	94.3	83.4	92.8
% trash	—	0.7	0.8	2.6	—

Fig. 1 Summary of 1957 harvest shows percentage of harvest and trash content

Designing a

L. H. Lamouria
Member ASAE

A. J. Winkler

G. H. Abernathy and
Assoc. Member ASAE

C. R. Kaupke
Assoc. Member ASAE

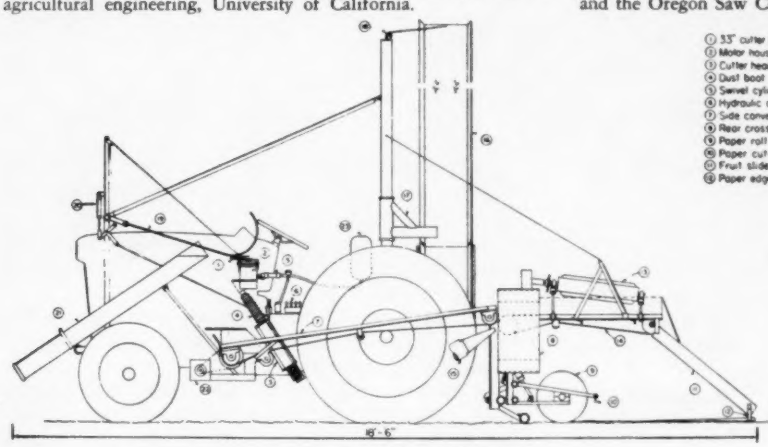
A MAJOR absorber of agricultural manpower in California—grape harvesting—has now been challenged through mechanical means. The economic and social factors involved in the harvest of wine and raisin grapes made mandatory the development of a harvester. During the 2-month period prior to harvest(1)*, a 2,000-man labor force has been required in the San Joaquin Valley vineyards. And these manpower needs have increased 3,000 percent during the harvest peak. Extra laborers, when available, were largely migratory workers. Acute social problems and unstable labor supply resulted.

Paper presented at the Winter Meeting of the American Society of Agricultural Engineers in Chicago, Ill., December, 1957, on a program arranged by the Power and Machinery Division.

The authors—L. H. Lamouria, A. J. Winkler, G. H. Abernathy and C. R. Kaupke—are respectively, associate professor of agricultural engineering, professor of viticulture, University of California; assistant professor of agricultural engineering, New Mexico A & M College, formerly assistant specialist of agricultural engineering, University of California; and assistant specialist of agricultural engineering, University of California.

*Numbers in parentheses refer to the appended references.

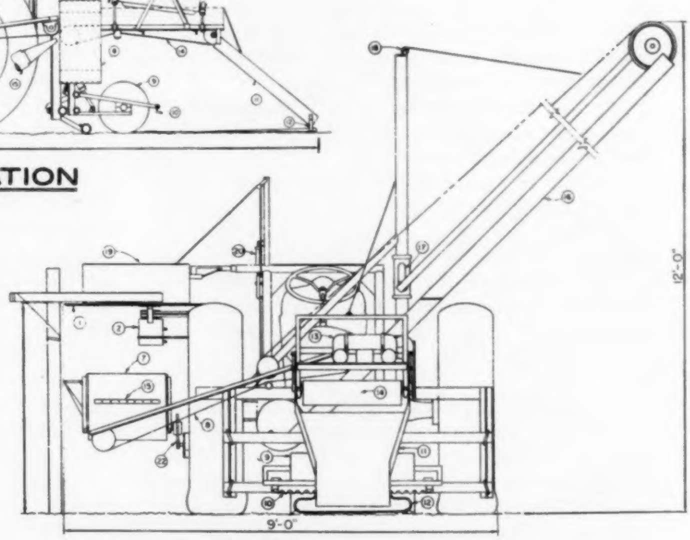
Acknowledgments: The authors acknowledge the assistance and counsel of William M. Regan, Jr., agricultural engineer, Food Machinery Corp.; John B. Powers, agricultural engineer, University of California at Los Angeles; the California Raisin Advisory Board; and the Oregon Saw Chain Corp.



SIDE ELEVATION

1. 33" cutter bar
2. Motor housing
3. Cutter head support
4. Dust boot
5. Swivel cylinder
6. Hydraulic controls
7. Side conveyor
8. Rear cross conveyor
9. Paper roll
10. Paper cut-off
11. Fruit slide
12. Paper edge curler
13. Fruit spreader
14. Spreader conveyor
15. Air discharge
16. Elevator
17. Elevator support & swivel
18. Elevator lift pulley
19. Cone depressor
20. Lift cylinder
21. Vine lifter
22. Conveyor drive motor
23. Accumulator

Detailed drawing of harvester. Fig. 2 *(Above)* Shows side elevation • Fig. 3 *(Right)* Shows rear elevation



REAR ELEVATION

Grape Harvester

Engineers, with assistance from plant breeders, have developed a grape harvesting machine that not only reduces labor requirements, but approaches hand-picking efficiency

In 1953 a research program was initiated to alleviate the problems of detrimental peak labor demands, high unit cost of production, and product sanitation control. This research developed a unique trellising-training system for the vines (2, 3) and a mechanical harvester.

Harvester Results

The harvest summary is shown in Fig. 1. The harvest efficiencies were a direct function of stem length. Clusters of long-stem varieties hung free below the trellis but with short-stem varieties the top of the cluster tended to be in or above the plane of the wire. Cutter efficiency dropped markedly (see Missions in Fig. 1) whenever the cutter was cutting through clusters rather than stems. A harvest yield of 90 percent in commercial vineyards was the goal. The fruit that remained on the trellis was economically gleaned with one man-minute of hand labor per vine. (Normal hand harvest resulted in about 95 percent of the fruit being delivered to the receiver.)

The Design Problem

On the premise that the fruiting wood could be held above the wires on a horizontal trellis with the fruit hanging below the wires, the problem resolved itself into the following major design considerations:

(a) Cutter mechanism
(b) Carrier for the cutter that would cause the cutter to follow the contours of the underside of the trellis
(c) Safety mechanism for the cutter bar
(d) Trash removal system

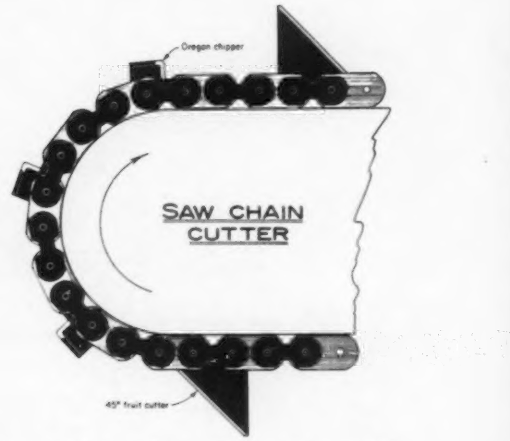


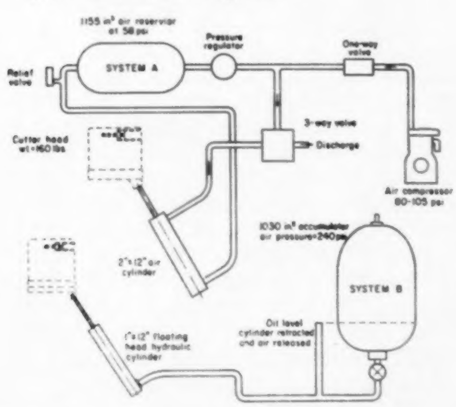
Fig. 4 The saw-chain cutter has a sequence of three chippers and one fruit cutter with a 1-in. projection

(e) Fruit spreading mechanism
(f) Paper-lay and cut-off mechanism
(g) Steering guidance system

The Solutions

An assembly of the solutions is shown in Figs. 2 and 3. Vines trailing to the ground were elevated to clear the cutter bar. The clusters, cut by the cutter, fell through a blast of cleaning air and were then conveyed rearward. At the rear of the side conveyor a second air discharge was available. The crop was then either elevated for utilization as wine grapes or spread and deposited onto a continuous paper tray for processing as raisins.

Cutter Bar — The cutter (Figs. 2 and 3) was a saw chain utilizing a sequence of three chippers and one 53-deg fruit cutter with a 1-in. projection. The saw chain illustrated (Fig. 4) shows a 45-deg fruit cutter because subsequent investigation by Feller(4) proved that the 45-deg cutter was preferred. The cutter bar was supported near its center of gravity so that a tilt feature could be included. This action permitted the bar to follow all the wires in the trellis even though the cross arms in the trellis varied ±10 deg from the horizontal. A double reciprocating sickle with 2-in. knife sections was also used(5).



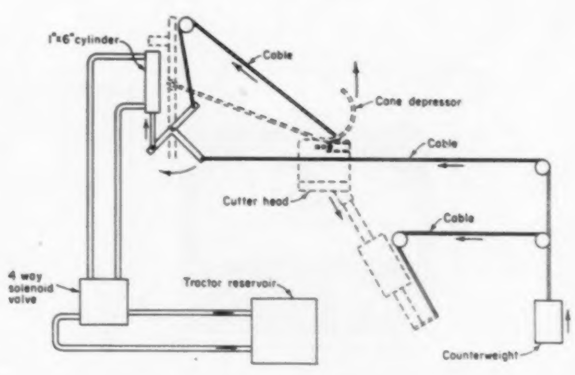


Fig. 5 (Left) Two systems for obtaining cutter head flotation. System A is pneumatic and system B is a closed accumulator circuit • Fig. 6 *(Right)* Cane depressor and counterweight raising mechanism replaced systems shown in Fig. 5

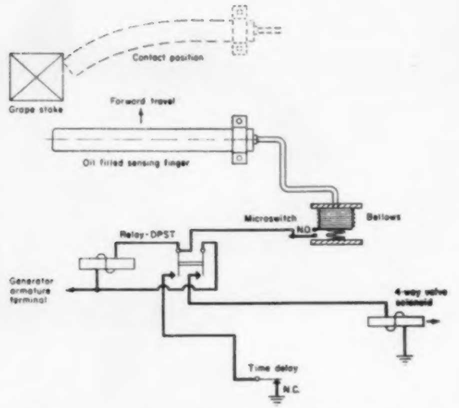


Fig. 7 Hydra-electric sensing unit withdrew cutter before obstructions were encountered

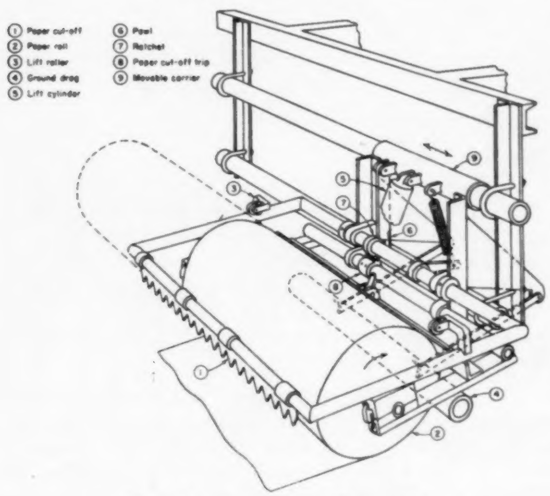


Fig. 8 Paper lay and cut-off assembly

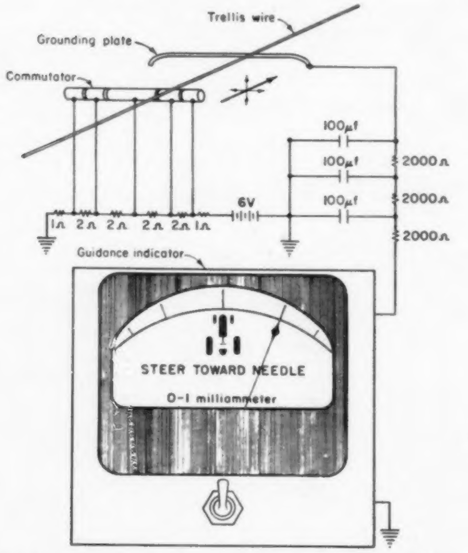


Fig. 9 An integrating guidance circuit was used for assistance in tractor steering

. . . Grape Harvester

Flotation — Flotation of the cutter bar was achieved with three different systems of control. Systems A and B are shown in Fig. 5. In a normal 4-in. change in elevation of the cutter bar, the pneumatic system lift-force varied by 2.3 lb, whereas, with the closed accumulator circuit, the lift-force varied by 1.2 lb. Although both systems A and B were used, they were finally discarded in favor of the counterweight system shown in Fig. 6. The saw-chain cutter assembly required only 55.5 percent of the counterweight used with the reciprocating head. With a constant torque of 100 lb-ft applied to the cutter bar, the force required to initiate vertical movement (overcome static friction) was 50 lb for each of the cylinder systems and 30 lb for the counterweight system. In all cases, a ball-bushing housing guided a pair of tubular shafts hardened to 40 Rockwell C. The seizure of the O-ring in the supporting cylinder caused the undesirably high static friction. If the static friction of the closed accumulator circuit and the counterweight system were equal, the accumulator circuit would have been preferred because of its simplicity. An overbalancing force of 45 lb (net 15) was used to assure vertical movement. This fòrce compensated for the static energy loss and the retracting force that resulted from telescoping of the support, which inclines 33 deg from the vertical in the direction of travel. It was advantageous to lean the cutter support in the direction of travel so that the cutter bar, on meeting an obstruction, would immediately move both downward and rearward. This action reduced the strain on the supporting structure and tended to free the bar from its obstruction.

Lateral Retraction — At first it was deemed necessary to cut the area that was in line with the grape stakes. This meant that the cutter bar had to be withdrawn from that region whenever a stake was in the path of the cutter. This was accomplished with a hydra-electric circuit (Fig. 7) with a sequence of sensing, retraction, time delay, and return. Although it was functional, improved vine-training techniques soon made it superfluous. After two years of fruit wood management, the fruit was brought entirely into the region between the tractor and the stakes.

TABLE 1. HYDRAULIC MOTOR PERFORMANCE

	INTERNAL SYSTEM			EXTERNAL SYSTEM			
				SAW CHAIN CUTTER		RECIPROCATING CUTTER	
	REAR CONVEYOR SYSTEM (WINE)	RAISIN LAY SYSTEM	SIDE CONVEYOR	BLOWER	CUTTER	CUTTER	BLOWER
ENGINE RPM	2140	2180	2140	2160	2150	2190	2150
PUMP RPM	–	–	–	1170	1170	1190	1170
INPUT PRESS., PSI	900	900	360	530	540	340	520
DISCH. PRESS., PSI	65	55	20	125	48	75	130
ΔP, PSI	835	845	340	405	492	265	390
MOTOR RPM	360	490	165	3350	3300	1990	3150
RUNNING TORQUE lb.-in.	135	137	55.1	65.6	79.6	47.5	63.2
STALL TORQUE lb.-in.	101	103	41.3	49.2	59.7	35.6	47.4
FLOW, GPM	2.46	3.13	1.13	17.7	17.5	14.6	16.7
HP	0.77	1.07	0.14	3.49	4.17	1.5	3.16
CUTTER SPEED, FPM	–	–	–	–	2670	332	–

Pump: Be-Ge Model 1000–9 rated at 30 GPM at 1000 RPM, 600 PSI max. continuous pressure, 11.9 HP input

Tractor: Ford Model 600 operated at maximum governed engine speed

Motors: Reciprocating cutter–Vickers Model M210-25-1C-1; all others Denison Model TMB 12F

Cutter Bar Protection — Ultimate protection for the cutter bar was provided by the closed accumulator circuit shown in Fig. 2. This system maintained 100 lb-ft of torque on the bar carrier. Whenever the cutter bar was driven into an obstruction (grape stake) the tip of the bar was dragged across the interference point. With this system the cutting action was continuous and the bar returned to its normal position as soon as the obstruction was passed.

Fruit Spreader — The lay of fruit on the tray was not to exceed a depth of one cluster diameter. To accomplish this, the fruit was discharged from the rear conveyor to one side of the spreader conveyor (Figs. 2 and 3). The spreader then moved fruit that was more than one cluster diameter deep to the empty portion of the spreader conveyor.

Paper Lay and Cut-Off — The paper-lay mechanism and cut-off device is shown in Fig. 8. The paper was unrolled by means of ground contact. A cut-off knife was spring loaded to a mean torque of 105 lb-ft and was held in the cocked position while the paper was unrolled. During the lift of the paper roll, the knife was tripped and paper cut when the roll-support arms were 7 deg above the horizontal. As the lift continued, the roll support arms carried the knife upward to the cocked position. Knife velocity at contact was 18 fps. Both paper and polyethylene film were cut satisfactorily. The lifting and cutting could be accomplished with the tractor halted or in motion. To prevent loose berries from rolling off the tray, a paper-edge curler (Fig. 3) held a temporary curb at the paper edge as it was being laid.

Trash Removal — A centrifugal blower provided 150 cfm of air at a discharge velocity of 1500 fpm (Fig. 2). Although the percentage of trash (Fig. 1) may be acceptable at a winery, additional cleaning is needed for raisins. Loose leaves were largely removed by an air carrier, but trash attached to fruit stems remained with the fruit. Improved vine training practice and long-stem varieties will provide a solution.

Tractor Guidance — Reference points normally sufficient for steering a tractor are inadequate when harvesting grapes. Stake extensions (markers) were used to indicate the stake position in the foliage, but even then, considerable skill and practice were required to keep the cutter within 4 in. of the stakes. In an attempt to solve the steering problem, a simple, integrating guidance circuit (Fig. 9) was developed. The system was designed so that its circuit was completed by contact with one of the trellis wires. The current flow to the visual indicator (a 0-1 milliammeter) varied with the position of the trellis wire relative to the commutator segments. A lateral movement of 2 in. was permitted for an On-Course indication. Additional lateral displacement of the cutter relative to the trellis wire varied the voltage impressed across the integrating circuit so that a steering correction was indicated. Because of foliage, continuous wire contact was not expected. The circuit build-up time was 0.8 seconds (0 to 90 percent level). It was hoped that the circuit discharge time of 0.5 seconds (20 percent decay) would bridge the time interval between contacts. However, in practice the guidance indicator was effective only about 40 percent of the time. Lost contact time was greater than the circuit hold period. Additional research will be conducted to obtain a faster build-up and a slower decay time. A variable-frequency detection circuit independent of trellis-wire contact will also be investigated. *(Continued on page 236)*

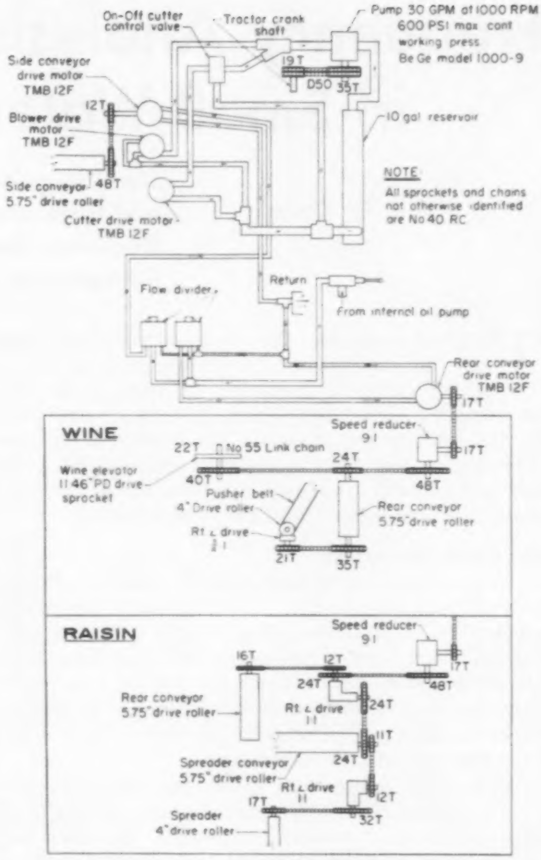


Fig. 10 External and internal hydraulic systems

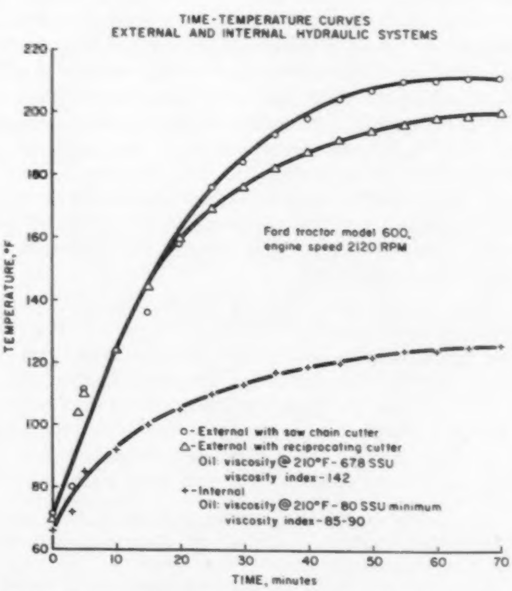


Fig. 11 The temperature rise of hydraulic oil with respect to time

Frequency Analysis in Small Watershed Hydrology

Ven Te Chow

Since a significant difference in hydrology exists between small and large watersheds, the author presents the application of frequency analysis as it pertains only to small watersheds or for upstream regions which comprise most agricultural areas

THIS paper discusses the small watershed hydrology and the application of frequency analysis to this branch of science. It describes the nature of the small watershed with which agricultural engineers are concerned. For frequency analysis, it explains the selection of data, use of theoretical laws for frequency distribution, plotting of data, and practical considerations on the use of short-term runoff data generally available for small watersheds.

The Small Watershed

Modern hydrology of surface runoff from watersheds is branched forth into two distinct fields of studies, namely, the headwater or upstream hydrology and the downstream hydrology. The former is concerned with the small upstream watersheds and the latter with the hydrology of large watersheds. As most agricultural areas are in upstream regions, the small watershed hydrology has become a subject of importance to agricultural engineers.

Hydrologic investigations have shown that there is a significant difference between the hydrologies of small and large watersheds. For small watersheds the rates and amounts of runoff are influenced by the physical condition of soil and cover over which man has some control, and thus most attention in hydrologic study is given to the watershed itself. For large watersheds the channel-storage effect becomes very pronounced and most attention is given to the hydrology of the stream. In hydrologic study, direct measurements of runoff at individual stream locations are generally used, and often extrapolated and extended. For small watersheds, on the other hand, it has been necessary to use a statistical "sampling" procedure because the task of gaging each individual watershed where runoff data might be required would be impossible. In this procedure reliance is placed largely on sampling of upstream areas with extension of findings to other areas by means of rainfall-runoff relations, and evaluation of the climatic and physiographic factors influencing runoff.

The favorable consideration for the use of frequency analysis in small watershed hydrology is evident. For numerous structures controlling minor floods on farm lands and along roadways, the method of frequency analysis makes feasible a rational economic analysis for the design purpose. It should be noted that the nature of these structures is different from that of those structures designed for major floods, such as the spillway of a dam, flood walls, etc. For the latter type of structures, more elaborate consideratons should be taken for the determination of a design discharge, because the failure of such structures might involve loss of human life and cause a catastrophe of such a great extent that the design cannot be justifiably made merely on the basis of the calculated risk obtained from a frequency analysis.

Principle of Frequency Analysis

By the method of frequency analysis, hydrologic data are treated as statistical variables. The frequency distribution of the data is examined by an analytical approach and the magnitude of the variable of a given recurrence interval is determined. The recurrence interval is defined as the average interval of time within which the magnitude of a given variable is equaled or exceeded.

Fig. 1(A) exhibits a set of runoff data from a watershed observed in 20 years and plotted in a chronological order. The magnitude is in cubic feet per second of daily peak discharge. The figure does not show 365 values in each year since the stream is assumed to be non-perennial. Experience has indicated that many of the original data have practically no significant value in the analysis because the hydrologic design of a structure is usually governed by a few of the extreme conditions only. In order to save labor and time in the analysis a portion of the data which is of insignificant magnitude can be excluded. For this purpose, two types of data are generally used in the analysis: the annual maximum values and the exceedance values.

The annual maximum value is the largest of all observations taken in a year. Thus, for 20 years of record there are 20 annual maximum values as shown in Fig. 1(B). The annual exceedance value is the value which is greater than a certain base value. If the base value is selected in such a way that the number of the exceedance values is equal to the number of years of record, then the exceedance values may be called annual exceedance values. Fig.1(C) shows the annual exceedance values for the 20 years of record. It may be noted that, when annual maximum values are selected, there is possibility of ignoring the effect of the second largest values in each year whose magnitude may outrank many annual maximum values. On the other hand, when exceedance values are selected, the second largest values are included in the analysis, but these values may be so close to each other and to the maximum values in their time of occurrence that one value could affect another which follows closely after. For instance, one flood may set the stage for the next close flood and one storm may disturb the meteorological condition for the subsequent ones. Consequently the selected data are not fully independent events. Logically speaking, the exceedance values should fit the

Paper presented at the Winter Meeting of the American Society of Agricultural Engineers in Chicago, Ill., December, 1956, on a program arranged by the Soil and Water Division.

The author—VEN TE CHOW—is associate professor of hydraulic engineering, civil engineering department, University of Illinois.

purpose of the analysis if the second largest values would affect the design. In this case the structure is designed not only for the momentary peak discharge, but also for the repeated occurrence of secondary peaks following the main peak, such as a culvert in which damage or destruction due to the peak discharge may be rapidly and economically repaired and then soon again exposed to damage due to secondary peaks. For structures designed for critical peak discharges, the annual maximum values would be suitable. As a rule, the annual exceedance values would yield higher magnitude of discharge than the annual maximum values for the same recurrence interval. From both practical and theoretical viewpoints, however, the two types of data give essentially identical results for recurrence intervals greater than about 10 years(1).*

After the data are selected, it is assumed that they follow a certain pattern of frequency distribution. Take the annual maximum values in Fig. 1(B) as an example and reproduce the plot as shown in Fig. 2(A). The horizontal line AB indicates the position of the mean $\bar{y}$ of all observed data whose magnitude is represented by a variable y. It is evident that any particular value of y can be expressed by

$$y = \bar{y} + \Delta y \qquad [1]$$

in which Δy is the departure from the mean. By statistics, it can be shown that the value of Δy may be expressed by the product of two factors σ and K.

The factor σ is a statistical parameter called the standard deviation, indicating the tendency of the data to deviate from the mean. It is expressed by

$$\sigma = \sqrt{[N/(N-1)](\overline{y^2} - \bar{y}^2)} \qquad [2]$$

in which $\bar{y} = \Sigma y/N$, $\overline{y^2} = \Sigma y^2/N$, and N is the total number of the observed data.

The factor K, called the frequency factor, is used to correlate with the frequency of occurrence. Its value depends upon the frequency distribution of the data. Thus, equation [1] may be written as

$$y = \bar{y} + \sigma K \qquad [3]$$

or

$$y/\bar{y} = 1 + C_v K \qquad [4]$$

*Numbers in parentheses refer to appended references.

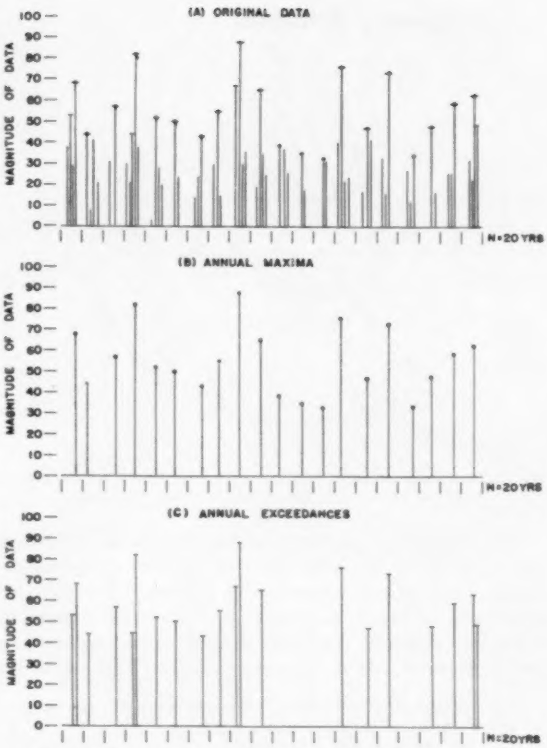


Fig. 1 Hydrologic data arranged in the order of occurrence

in which $y/\bar{y}$ is called the y-mean ratio and C_v is known in statistics as a coefficient of variation equal to $\sigma/\bar{y}$.

Fig. 2(B) shows a frequency curve for the theoretical distribution which would fit the data in Fig. 2(A). The curve is plotted with the magnitude against the number of items of occurrence or the frequency. The cumulative frequency curve or probability curve corresponding to the frequency curve of Fig. 2(B) is shown in Fig. 2(C). This is plotted with the magnitude against the probability of recurrence of an event equal to or greater than magnitude y.

There are two theoretical laws most commonly used for defining the distribution of annual maximum values — the extreme-value law and the log-probability law.

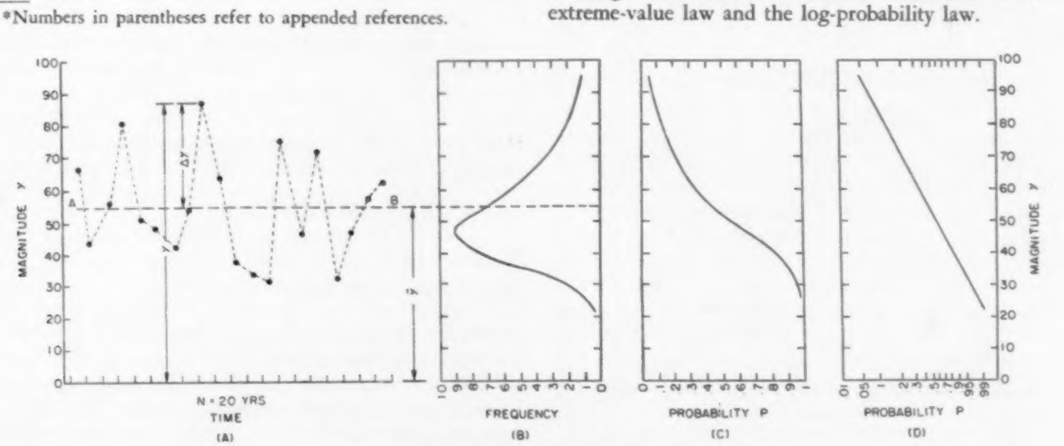


Fig. 2 Frequency distribution

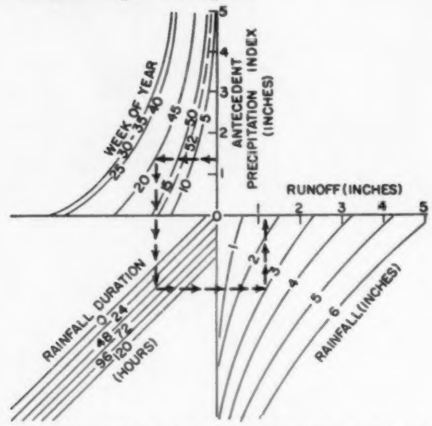


Fig. 3 A coaxial rainfall and runoff relationship chart for Monocacy RR at Jug Bridge, Md. (U.S. Weather Bureau)

The extreme-value law was first introduced by Fisher and Tippett (2) in 1928 and later applied to hydrologic data by Gumbel (3) in 1941. By this law it is stated that the annual maximum values of N years of record approaches a definite pattern of frequency distribution when the number of observations in each year becomes large. For this pattern of frequency distribution, it can be shown that the frequency factor is expressed by

$$K = -\frac{\sqrt{6}}{\pi}\left\{\gamma + \log_e[\log_e T - \log_e(T-1)]\right\} \quad [5]$$

in which $\gamma = 0.5772157$ . . . a so-called Euler's constant and T = recurrence interval in years (4). If an event equal to or greater than a magnitude y occurs in T years, the chance of recurrence or the probability P is equal to 1 in T cases, or $P = 1/T$; hence $T = 1/P$. P is the probability of recurrence of an annual maximum value equal to or greater than magnitude y. Thus, equation [5] becomes

$$K = -\frac{\sqrt{6}}{\pi}\left\{\gamma + \log_e[-\log_e(1-P)]\right\} \quad [6]$$

This equation gives the relationship between the probability P and the frequency factor K, whereas equation [5] gives the relationship between the recurrence interval T and K.

The log-probability law was first studied by Galton (5) in 1875 and later applied graphically to hydrologic data by Hazen (6) in 1914. By this law it is stated that the logarithms of annual maximum values are normally distributed. Mathematical analysis has shown that the frequency factor for this distribution depends not only upon the probability P (or upon the recurrence interval T, since $T = 1/P$), but also upon the coefficient of variation C_v and the coefficient of skewness C_s. The value of C_s is a measure of asymmetry of the distribution pattern and can be computed by

$$C_s = \frac{N^2}{(N-1)(N-2)}\,\frac{\overline{y^3} - 3\bar{y}\,\overline{y^2} + 2\bar{y}^3}{\bar{y}^3 C_v^3} \quad . \quad [7]$$

Computation of the frequency factor for given values of C_v and C_s is mathematically complicated. For the simplicity of computation, a table of frequency factors has been prepared (7) and the values of frequency factor can be obtained either directly or by interpolation from this table for given values of C_v, C_s, and P.

As exceedance values are only values above an arbitrary base value, they do not form a complete frequency series. Therefore, they are also known as values of a partial duration series. Experience obtained in early years, such as by the California Department of Public Works (8) in 1923, indicates that the exceedance values fit satisfactorily in many cases to an exponential law. However, the theoretical verification of this law was not made until 1951 by Chow (1). By this law, the distribution of exceedance values is shown to be exponential. In other words, the frequency factor of this distribution is

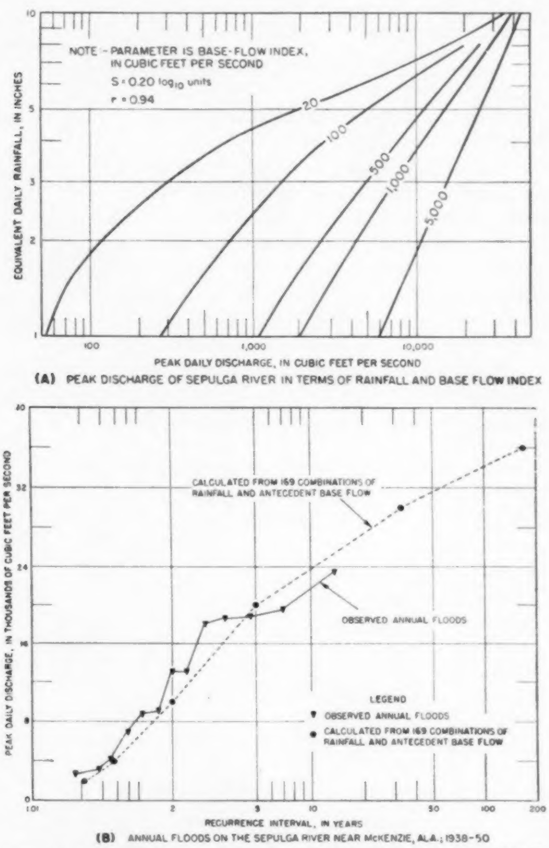
$$K = n + m \log_{10} T \quad . \quad [8]$$

or

$$K = n - m \log_{10} P \quad . \quad [9]$$

in which n and m are parameters that can be determined by the method of least squares.

The above-mentioned theoretical laws of frequency distribution are commonly employed, because they fit most hydrologic data satisfactorily. When a certain distribution law is adopted, the corresponding frequency factor can be



Figs. 4A and 4B Extension of a flood-frequency graph (after W. B. Langbein, U.S. Geological Survey)

determined by either formula or table. With the computation of $\bar{y}$ and C_v, the magnitude y for a given recurrence interval can be thus determined by equation [3].

It is convenient for practical purposes to plot the probability curve, such as that of Fig. 2(C), in a straight line. This can be done by transforming the scale of the ordinate in such a way, as shown in Fig. 2(D), that the curve would appear as a straight line. The construction of a probability paper with this transformed scale to fit a particular law of distribution can be easily understood by examining equation [3]. According to this equation, the magnitude y is a linear function of K. In other words, the curve would appear as a straight line for the theoretical distribution if y is plotted linearly against K. Most observed data will indicate a straight line trend, and hence a straight line of fitness can be determined.

For the extreme-value law, a transformed scale for P (or T) can be constructed by means of equation [5] (or equation [6]) along the K-scale. By this principle, the well-known Gumbel-Powell paper was developed for plotting annual maximum values (9). For the exponential law, the frequency factor is simply a logarithmic function of either T or P. Therefore, a semilogarithmic paper will serve the purpose. By the same principle for constructing the probability paper for annual maximum values, it is possible to construct a transformed scale for the log-probability law. However, it is found more convenient to use the regular normal-probability paper with a logarithmic scale for the magnitude y.

To plot the observed data on a probability paper, the plotted frequency is computed by a plotting position formula. The formula generally recommended for plotting annual maximum values is

$$P = \frac{m}{N+1} \quad [10]$$

or

$$T = \frac{N+1}{m} \quad [11]$$

in which m is the rank of the values arranged in an order of descending magnitude. Thus $m=1$ for the largest value (10). For exceedance values, the following formula is recommended:

$$P = \frac{m}{N} \quad [12]$$

or

$$T = \frac{N}{m} \quad [13]$$

After the observed data are plotted on the probability paper, a line of least squares can be computed. This line represents the probability curve for the given data.

Considerations of Short-Term Records

A difficulty confronting the application of frequency analysis to small watershed hydrology lies in the fact that most data available have a short period of record, generally less than 20 years, which does not warrant a reliable determination of frequency. To estimate runoff discharges with recurrence intervals greater than the period of record has been done by interpolation of the probability curve, but this practice is lacking in reliability and is not generally recommended. However, if the extension of frequency data is made on a sound physical basis, the result can be considered much more reliable. For this purpose, two recently developed methods are recommended. These methods are based on a sound rainfall-runoff relationship for extending the short runoff frequency data to a much longer period from a relatively long rainfall data. This is possible because rainfall data generally predate the corresponding runoff data.

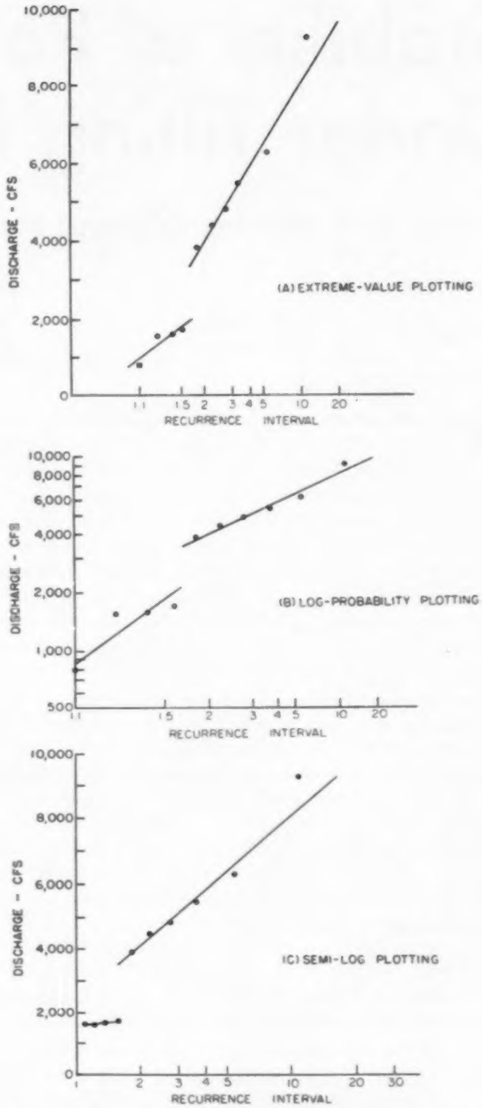


Fig. 5 Probability plotting of discharges for Indian Creek at Wanda, Ill.

One method was developed by Kresge and Nordenson (11) as a result of study by the U.S. Weather Bureau with the cooperation of the U.S. Bureau of Public Roads. This method consists of *(a)* obtaining adequate long-period rainfall data from stations located within or close to the drainage area, *(b)* estimating the volume of the direct runoff corresponding to the rainfall data by means of a coaxial rainfall-runoff relationship chart developed for the basin in question, *(c)* applying the unitgraph analysis to determine the

(Continued on page 231)

Stability of Poles Under Tilting Moments

Part II — Mechanics and Application to Experimental Results

G. L. Nelson
Member ASAE

Follow-up on experimental data presents an analysis of relationship between anchorage behavior and pole bending as design aid in pole-type farm construction

RESULTS from an experimental testing program described in Part I(2)* have indicated that when poles anchored in clayey soil are subjected to tilting moments, rotation occurs in a vertical plane about a point between mid-depth and ⅔-depth of the anchorage. Horizontal movement of the pole caused by this rotation can be reduced by *(a)* the use of concrete as compared to tamped earth for backfilling around the pole, *(b)* increasing the depth of the anchorage, *(c)* keeping soil around the anchorage dry, and *(d)* possibly by preconsolidation of soil around the anchorage to increase the soil elastic modulus.

An analysis of the mechanics of loading and the resulting rotation of a pole anchored in soil is needed in order to study separately the effects of yielding of the earth and bending of the pole under tilting moments; and to evaluate the relative importance of rigidity of the anchorage and stiffness in the pole, respectively. Obviously, it is not economical or consistent with efficient structural design to use poles in end anchorages which permit much greater movement of the pole caused by rotation of the anchorage than that caused by elastic bending of the pole.

Analysis

In order to develop an analysis it was found necessary to make use of certain assumptions and conditions:

(a) When the pole is loaded by a tilting moment, rotation occurs in a vertical plane about a fixed point between the butt of the pole and the ground line.

(b) The horizontal reaction on the pole from earth or concrete in the pole anchorage during application of tilting moments has a distribution defined by a parabola with the axis horizontal. This reaction is zero at the point about which the pole rotates, and at the ground surface.

(c) Concrete used for backfilling the anchorage does not contribute to the stiffness of the pole in bending. Experiments have shown that the concrete usually ruptures into pie-shaped fragments before or during loading.

(d) Angular rotation of the pole in a vertical plane is small enough that changes in the geometry of loading caused by pole rotation are negligible. Differences between the arc and chord swept through by a point on the pole as it rotates are negligible.

(e) The pole has the shape of a cylinder of uniform radius below grade and a tapered cylinder above grade such that the variation in $1/I$ is linear with distance from the butt of the pole, where I is the moment of inertia of the pole cross section at any point.

(f) The modulus of elasticity of the pole is constant.

The geometry of loading and the soil reaction on the pole are shown in Fig. 1. For the below-grade portion of the pole:

$$EI\frac{d^4 y}{dx^4} = p \qquad [1]$$

To evaluate p, the below-grade reaction on the pole, the assumption of parabolic load distribution on the below-grade portion of the pole can be used and the equation of the loading curve written according to the general expression for a parabola, where g, and f and c are constants.

$$x^2 + 2gx + 2fp + c = 0 \qquad [2]$$

Constants g and c can be evaluated by making use of the conditions that p is zero at x of zero and d, respectively. This gives p in terms of f.

$$p = \frac{dx - x^2}{2f} \qquad [3]$$

Since the pole is in equilibrium,

$$\int_0^D \frac{dx - x^2}{2f}(dx) = -P \qquad [4]$$

which when integrated gives

$$f = -\frac{1}{2P}\left(\frac{dD^2}{2} - \frac{D^3}{3}\right) \qquad [5]$$

If this value for f is used in equation [3], the result is

$$p = \frac{dx - x^2}{\dfrac{-(3dD^2 - 2D^3)}{6P}} = \frac{dx - x^2}{\lambda} \qquad [6]$$

The value of p in equation [6] can be used in equation [1],

*Numbers in parentheses refer to the appended references.

Preliminary report presented at the annual meeting of the American Society of Agricultural Engineers at the University of Illinois, Urbana, June, 1955, on a program arranged by the Farm Structures Division. Part I was published in AGRICULTURAL ENGINEERING 39:166, March, 1958.

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which is then readily integrable. By integrating equation [1] four times and using the following conditions to evaluate the constants of integration,

$$EI\frac{d^3y}{dx^3} = P \text{ at } x = 0$$

$$EI\frac{d^2y}{dx^2} = PH \text{ at } x = 0$$

$$y = 0 \text{ at } x = d$$

$$y = \delta \text{ at } x = 0$$

the slope, ϕ, of the pole axis at the ground line becomes:

$$\Phi = \frac{dy}{dx} = -\frac{\delta}{d} - \frac{\alpha^2 PD^2}{2EI}\left[\frac{\alpha^3}{15(2-3\alpha)} + \frac{1}{\alpha\gamma} + \frac{1}{3}\right] \quad [7]$$

where

$$\alpha = \frac{d}{D} \qquad \gamma = \frac{D}{H}$$

It will be noted that the first term of equation[7] evaluates rotation caused by consolidation of the soil Φ_{SC}. The second term evaluates rotation caused by elastic bending Φ_{BBG} of the pole below the ground line (see Fig. 1).

Location of Point of Rotation

Before equation[7] can be applied to determine the slope of the elastic curve for the loaded pole at the ground line, the depth, *d*, below grade of the point of rotation must be known. Since the pole is in static equilibrium, the external moment, *PH*, at the ground line resulting from load *P* at the pole top can be written in terms of the known below-grade load distribution of earth forces. If the resulting expression is integrated, it becomes

$$PH = \frac{dD^3}{3\lambda} - \frac{D^4}{4\lambda} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [8]$$

Also

$$P = -\int_0^D \frac{dx - x^2}{\lambda}\,dx = -\left[\frac{dD^2}{2\lambda} - \frac{D^3}{3\lambda}\right] \quad . \quad . \quad . \quad . \quad [9]$$

Substituting *P* from equation[9] in equation[8] an expression for α is obtained:

$$\alpha = \frac{3\gamma + 4}{4\gamma + 6} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [10]$$

Accordingly, the variations in α is slight and varies from ⅔ at γ of zero, an impossible situation, to 7/10 at γ of unity.

Experimental evidence indicates that these theoretical ratios are too high. The average ratio as obtained by direct measurement of position of the poles in the earth after loading for five different anchorages in previous experiments (2) is 0.573. Krynine(1) reported some model pile-loading tests conducted with posts 3 to 3½ in. in diameter and 6 to 7½ ft long driven into uniform clay of 17 to 18 percent water content. The points of rotation were from 0.52*D* to 0.69*D* below the surface. Shilts, *et al* (3) reported results of horizontal loading tests on steel sign posts of special designs, some of which were equipped with stabilizing wings, or set in ground at depths of 5 to 8 ft with concrete or soil cement encasements. The average depth of the point of rotation was 0.589*D*. Krynine(1) observed that after the first slight initial rotation of a pile subjected to overturning moment, the point of rotation began to move upward as additional moment was applied.

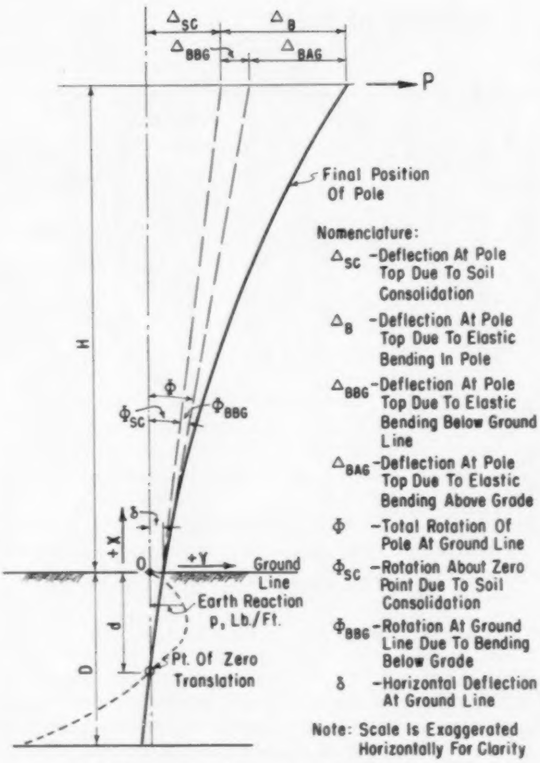

Fig. 1 Geometry of loading and deflection of a pole anchored in the earth

All this evidence indicates that the actual point of rotation is higher than the location calculated on the basis of a parabolic earth pressure distribution. A *d*/*D* ratio of 0.6 seems reasonable. With α evaluated, the slope of the pole at the ground line resulting from the applied load can be computed for any small amount of movement δ at the ground

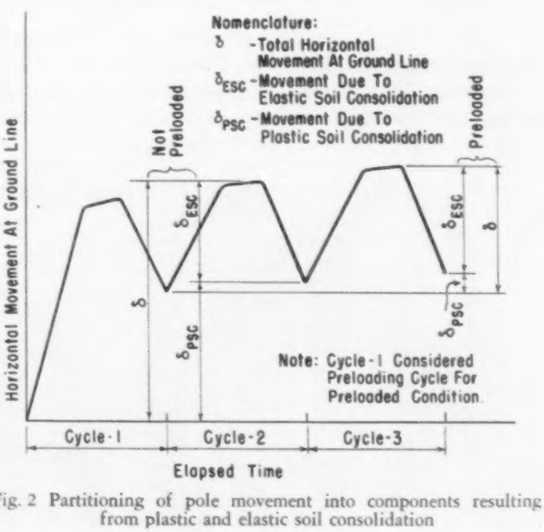

Fig. 2 Partitioning of pole movement into components resulting from plastic and elastic soil consolidation

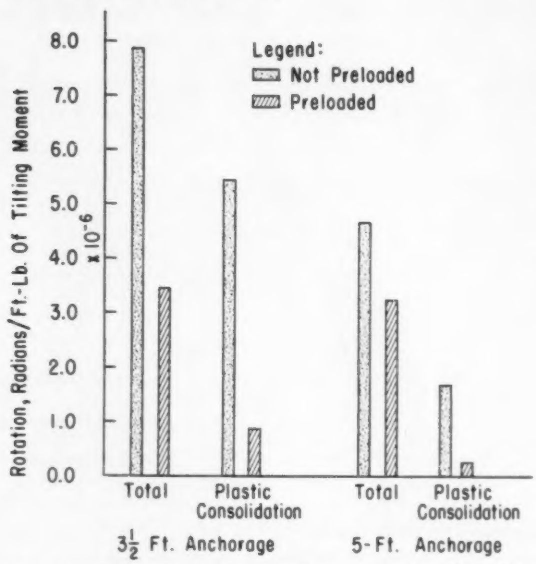

Fig. 3 Comparison of rotation of anchorages resulting from plastic consolidation of soil in the preloaded and non-preloaded conditions, respectively

line if the depth of the setting and the elastic properties of the pole are known by inserting the appropriate values in equation[7]. The rotation as expressed by the first term of equation[7] resulting from movement δ will depend only on the volume change which the soil undergoes because of consolidation pressures from the pole. Some of the consolidation will be elastic, or recoverable, and some will be plastic, or non-recoverable. It appears unfeasible to predict movement on the basis of consolidation tests on samples of soil because of the heterogeneous nature of most soil profiles in the upper layers.

In order to evaluate the amount of rotation caused by soil consolidation, tests could be conducted at the building site, or in a soil profile which is typical of a number of building sites throughout a general area where pole frame buildings are to be erected.

Application to Experimental Data

Data obtained in loading experiments previously described (2) consisted of measurements of movement at pole tops and 6 in. above grade, respectively, caused by overturning moments resulting from horizontal loads at the pole top. These data were used in the present study to validate the results of the foregoing rational analysis, and to investigate the relative importance of rigidity of the anchorage and elastic bending of the pole in controlling movement of poles under tilting moments. The values of δ, movement at the ground line, were obtained from the observations 6 in. above the ground line by linear interpolation with respect to the point of rotation. Three loading and unloading cycles were applied to each test pole. Data on recovery during unloading provided a basis for partitioning the rotation caused by soil consolidation into two parts corresponding to plastic and elastic consolidation respectively. Also, the three cycles of loading with accompanying deflection data were used to analyze the effect on movement of preloading or preconsolidating the soil around the anchorage by tilting the pole.

The theoretical expression for slope of the pole axis at the ground line becomes, upon insertion of $d/D = 0.6$:

$$\Phi = -\frac{\delta}{0.6D} - 0.30\frac{PD^2}{EI}\left(0.243 + \frac{H}{D}\right) \qquad [11]$$

The analysis was conducted by using the first term of equation [11] to compute the rotation at the ground line caused by plastic soil consolidation, Φ_{PSC}; and elastic consolidation Φ_{ESC}. The values of δ_{PSC} and δ_{ESC} used in equation[11] were obtained from the test data as illustrated in Fig. 2. Two soil conditions, preloaded (PL) and not preloaded (NPL) were considered in the analysis. For the preloaded soil condition, δ_{PSC} and δ_{ESC} were measured as indicated in Fig. 2 in the last cycle. For the non-preloaded condition, δ_{PSC} and δ_{ESC} were measured in the second cycle. Thus, data for movement during the second cycle of repeated loading with and without a preloading cycle were available from the experimental data. For the preloaded condition, the first cycle is considered the preloading cycle.

The second term of equation[11] was employed to compute rotation Φ_{BBG} at the ground line resulting from elastic bending of the pole below-grade. The modulus of elasticity E for the Southern Pine creosoted poles was taken as 1.6 x 10^6. The cross-sectional moment of inertia of the pole below-grade was computed at mid-depth.

The results of this analysis of pole rotation at the ground line are tabulated in Table 1. The designated anchorages A-1, A-2, A-3, and A-4 are as described in Fig. 4. It is apparent from inspection of Table 1 that preloading can result in important reductions in rotation of the anchorages,

Depth - Ft.	Anchorage	Soil Condition	Rotation Due To Soil Consolidation: Total: Φ_{SC} Radians Per Ft.-Lb. x 10^{-6}	Total: Percent Of Total	Elastic: Φ_{ESC} Radians Per Ft.-Lb. x 10^{-6}	Elastic: Percent Of Total	Plastic: Φ_{PSC} Radians Per Ft.-Lb. x 10^{-6}	Plastic: Percent Of Total	Rotation Due To Elastic Bending: Φ_B Radians Per Ft.-Lb. x 10^{-6}	Elastic Bending: Percent Of Total	Total Rotation Φ Radians Per Ft.-Lb. x 10^{-6}
3½	A1	PL	2.946	75.87	1.741	44.84	1.205	31.03	0.937 For All Conditions	24.13	3.883
		NPL	9.589	91.10	1.893	17.98	7.696	73.12		8.90	10.526
	A2	PL	2.661	73.96	1.920	53.36	0.741	20.60		26.04	3.598
		NPL	6.554	87.49	1.804	24.08	4.750	63.41		12.51	7.491
	A3	PL	1.455	60.83	1.232	51.51	0.223	9.32		39.17	2.392
		NPL	4.090	81.36	1.170	23.27	2.920	58.09		18.64	5.027
	A4	PL	3.000	76.20	1.750	44.45	1.250	31.75		23.80	3.937
		NPL	7.616	89.04	1.241	14.51	6.375	74.53		10.96	8.553
	Avg.	PL	2.516	71.72	1.661	48.54	0.855	23.18		28.28	3.453
		NPL	6.962	87.25	1.527	19.96	5.435	67.29		12.75	7.899
5	A1	PL	1.589	52.05	1.277	41.83	0.312	10.22	1.464 For All Conditions	47.95	3.053
		NPL	4.892	78.97	1.321	20.78	3.571	56.19		23.03	6.356
	A2	PL	2.509	63.15	2.295	57.76	0.214	5.39		36.85	3.973
		NPL	3.143	68.22	2.232	48.45	0.911	19.77		31.78	4.607
	A3	PL	1.571	51.76	1.482	48.83	0.089	2.93		48.24	3.035
		NPL	1.892	56.38	1.446	43.09	0.446	13.29		43.62	3.356
	A4	PL	1.357	48.10	1.036	36.72	0.321	11.38		51.90	2.821
		NPL	2.768	65.41	1.045	24.69	1.723	40.72		34.50	4.232
	Avg.	PL	1.757	53.76	1.523	46.29	0.234	7.47		46.24	3.221
		NPL	3.174	66.75	1.511	34.25	1.663	32.50		33.25	4.638

Table 1 Analysis of pole rotation effects at ground line produced by two loading cycles

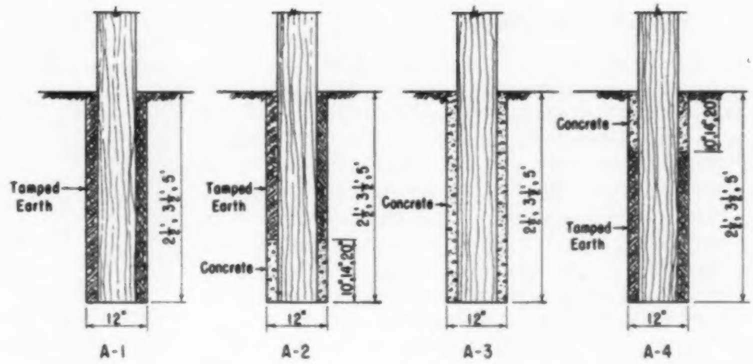

Fig. 4 Pole anchorages used in experimental testing program: A-1 is tamped earth, A-2 has concrete collar cast for lower one-third of below-grade portion with remainder tamped earth, A-3 is concrete, A-4 has concrete collar for upper one-third of below-grade portion with remainder tamped earth

especially for those which exhibit large amounts of rotation in the non-preloaded condition. For example, preloading was found to reduce the total rotation of poles placed 3½ ft deep, having tamped earth anchorage A-1, from approximately 10½ x 10^{-6} radians per ft-lb in the non-preloaded condition to less than 4 x 10^{-6} radians per ft-lb in the preloaded condition. The effect of preloading is less pronounced for the deeper anchorages and those which are inherently rigid, as for example A-3, which is a complete encasement around the pole. The reduction in rotation resulting from preloading seemed to be caused primarily by reduction in plastic consolidation. Anchorages A-1 which were completely backfilled with tamped earth underwent the largest amounts of plastic consolidation during the first or preloading cycle. Thereafter, their performance was comparable to other anchorages with concrete.

The effects of preloading on rotation at the ground line because of plastic consolidation and on total rotation, respectively, are summarized in Fig. 3. The average rotation resulting from plastic consolidation in the preloaded condition was only 16 percent of the rotation in the non-preloaded condition for the 3½-ft depth, and 14 percent of the rotation for the 5-ft depth. Total average rotation after preloading was only 44 percent of that in a non-preloaded condition for 3½-ft-deep anchorages; and 70 percent for the 5-ft-deep anchorages.

Evidently, preloading is effective in increasing the stiffness of pole anchorages. Krynine(1), has suggested this treatment for increasing the lateral resistance of piling. In the case of anchorages for poles used as main framing members for farm buildings, preloading might be conducted with a pull from a tractor, or a block and tackle arrangement between two opposite poles.

It is apparent that by a combination of a 5-ft-deep anchorage, a complete concrete encasement, and preloading treatment, the non-recoverable rotation at the ground line caused by plastic consolidation was reduced to less than 3 percent of total rotation per cycle at the ground line caused by elastic bending and soil consolidation. Some irreversible deformation may occur even in the stiffest anchorages, until a certain number of loading and unloading cycles have been applied. Krynine(1) refers to experiments with model piles in which the soil around the pile attained perfect elasticity after 30 cycles. It is possible that irreversible movement would not occur under service loads which are only a certain fraction of the preconsolidating load. The possibility that preconsolidation might tend to disappear after some time had elapsed should be considered.

In general, it would appear desirable to take full advantage of the potential rigidity of a pole frame by adopting anchorage designs which permit the pole to transmit a definite amount of moment from the frame into the ground without exceeding a certain specified amount of rotation. One-hinged or hingeless frames with ends fixed in the ground could be designed for maximum stiffness, wind resistance, and efficiency in utilization of materials. Current pole frame erection practice generally employs poles as simple columns, but requires certain precautionary measures to obtain a desirable but variable amount of resistance to tilting moment.

Analysis of Pole Type Deflection

Regardless of the stiffness of its anchorage, the top of a pole which supports a roof frame will deflect by an amount which depends partly on the rotation of the anchorage at the ground line, and partly on elastic bending in the pole

Table 2 Analysis of pole deflection effects at 14 ft above ground after two loading cycles of 11,200 ft-lb maximum moment

Depth, Feet	Anchorage Type	Soil Condition	Deflection Due To Soil Consolidation: Total Δ_{SC} In.	Total Percent Of Total	Elastic Δ_{ESC} In.	Elastic Percent Of Total	Plastic Δ_{PSC} In.	Plastic Percent Of Total	Deflection Due To Elastic Bending Δ_B In.	Elastic Bending Percent Of Total	Total Deflection At Pole Top: Computed In.	Measured In.	Diff. In.	% Error Diff. x 100 / Measured
3½	A1	PL	6.38	32.16	3.77	19.00	2.61	13.16	13.46 For All Conditions	67.84	19.84	21.93	-2.09	-9.53
		NPL	20.75	60.65	4.10	11.98	16.70	48.87		39.35	34.21	35.17	-0.96	-2.73
	A2	PL	5.75	29.93	4.15	21.60	1.60	8.33		70.07	19.21	18.13	+1.08	+5.96
		NPL	14.18	51.30	3.90	14.11	10.28	37.19		48.70	27.64	25.40	+2.24	+8.82
	A3	PL	3.15	18.96	2.67	16.07	0.48	2.89		81.04	16.61	14.37	+2.24	+15.59
		NPL	8.85	39.67	2.53	11.34	6.32	28.33		60.33	22.31	19.07	+3.24	+16.99
	A4	PL	6.49	32.53	3.79	19.00	2.70	13.53		67.47	19.95	21.06	-1.11	-5.27
		NPL	16.48	55.04	2.69	8.98	13.79	46.06		44.96	29.94	30.50	-0.56	-1.84
	Avg.	PL	5.44	28.78	3.59	18.99	1.85	9.79		71.22	18.90	18.87	+0.03	+0.17
		NPL	15.07	52.82	3.31	11.60	11.76	41.22		47.18	28.53	27.54	+0.99	+5.31
5	A1	PL	3.63	20.00	2.92	16.09	0.71	3.91	14.52 For All Conditions	80.00	18.15	15.63	+2.52	+16.12
		NPL	11.18	43.50	3.02	11.75	8.16	31.75		56.50	25.70	23.77	+1.93	+8.13
	A2	PL	5.73	28.30	5.24	25.88	0.49	2.42		71.70	20.25	23.80	-3.55	-14.92
		NPL	7.18	33.09	5.10	23.50	2.08	9.59		66.91	21.70	24.97	-3.27	-13.10
	A3	PL	3.59	19.82	3.39	18.72	0.20	1.10		80.18	18.11	18.27	-0.16	-0.88
		NPL	4.32	22.93	3.30	17.52	1.02	5.41		77.07	18.84	18.93	-0.09	-0.48
	A4	PL	3.10	17.59	2.37	13.45	0.73	4.14		82.41	17.62	16.16	+1.46	+9.03
		NPL	6.33	30.36	2.39	11.46	3.94	18.90		69.64	20.85	19.60	+1.25	+6.38
	Avg.	PL	4.01	21.64	3.48	18.78	0.53	2.86		78.36	18.53	18.47	+0.06	+2.34
		NPL	7.25	33.30	3.45	15.85	3.80	17.45		66.70	21.77	21.82	-0.05	-0.23

between the ground and the top of the pole. The experimental data on pole movement near the ground line were used to compute predicted values of deflection of the pole top. These values were compared to the experimentally measured values of the pole top deflection to evaluate the agreement between theory and experimental results.

The total deflection of the pole top, Δ, includes components caused by soil consolidation Δ_{SC} and elastic bending of the pole, Δ_B, as illustrated in Fig. 1. The deflection caused by soil consolidation is equal to the product of pole rotation resulting from soil consolidation and distance from the pole top to the point of rotation at $0.6D$. Deflection of the top caused by bending below grade Δ_{BBG} is equal to the product of angular rotation as computed by the second term of equation[11] and the pole height above ground. Deflection caused by bending above grade, Δ_{BAG}, can be computed directly from the second moment-area principle, which, when applied to cantilever loading of a pole, becomes:

$$\Delta_{BAG} = \frac{P}{E}\left[-2\ell\int_0^{\ell}\frac{x\,dx}{I} + \int_0^{\ell}\frac{x^2\,dx}{I} + \int_0^{\ell}\frac{\ell^2\,dx}{I}\right] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [12]$$

Here, l is pole length measured from the butt. In this expression, the moment of inertia, I, varies because of taper. Therefore, a regression expression for $1/I$ as a function of x, the distance in inches from the butt, was computed in order to make the expression for Δ_{BAG} integrable.

The results of the calculations for each component of pole top deflection based on application of the theoretical expression to observed movements of the pole 6 in. above ground line are presented in Table 2. The error in the computed deflection expressed as a percentage of the observed deflection has also been computed. The average error of the computed deflection of the pole top is +1.26 percent for the preloaded anchorages and —2.54 percent for the non-preloaded anchorages. It appears that the analysis by which equation[7] was developed gives a reasonable estimate of deflection at pole top if movement of the pole at the ground line is known.

The results of the analysis summarized in Table 2 clearly demonstrate that preloading of a pole anchorage can produce considerable improvement in the rigidity of a pole frame with anchorages 3½ ft deep, but that the effect is not so marked for the deeper, inherently more rigid anchorages with concrete backfill. For example, the computed deflection of poles with anchorage A-1, consisting of tamped earth 3½ ft deep was reduced from more than 34 in. in the non-preloaded condition to less than 20 in. by preloading. On the other hand, poles with anchorage type A-3, consisting of a complete concrete encasement, 5 ft deep, deflected an average of 18.84 in. in the non-preloaded condition. Preloading reduced the deflection to 18.11 in., or a decrease of only 0.73 in. resulting from application of 11,200 ft-lb preloading moment. The important effect of preloading appeared in deflection of the pole tops because of plastic consolidation of soil around the anchorage. Preloading reduced this plastic, or non-recoverable effect on the 3½-ft-deep anchorages from a mean of nearly 12 in. in the non-preloaded condition to less than 2 in. in the preloaded condition. For the 5-ft anchorages, the mean non-recoverable deflection of preloaded poles was approximately ½ in. at the pole top, as compared to approximately 3¾ in. for poles with non-preloaded anchorages. Anchorage type A-3, 5 ft deep, produced the least non-recoverable deflection of only 0.20 in. at the pole top after a moment of 11,200 ft-lb had been applied twice, preceeded by one preloading cycle. This deflection was approximately 1 percent of the total deflection, the remainder of which was produced by elastic action of the soil or pole.

In general, elastic bending of the pole was the major factor in deflection of nominal 5-in.-top poles anchored 5 ft deep, since it accounted for from approximately two-thirds to four-fifths of the pole deflection 14 ft above ground.

Conclusions

Quantitative evaluations of the rigidity of anchorages for poles subjected to tilting moments are necessarily limited in application to soil profiles comparable to the one in these experiments. The soil in which the test data were obtained was predominately clayey and hard when dry, but tending to become soft and plastic when wet. Also, the rotation effects of tilting moment applied to a pole anchorage may be influenced by the magnitude of the horizontal reaction which accompanies the moment. Subject to these limitations, the following conclusions are drawn from the present study.

(a) Assumption of a parabolic distribution of anchorage reactions against the pole yields an analysis which can be used to estimate deflections at the top of a pole with reasonable accuracy if the relationship between tilting moment and horizontal movement of the pole at the ground line is known or estimable.

(b) Preloading or preconsolidation of the soil around a pole anchorage should be used to obtain maximum rigidity of pole anchorages. By a combination of preconsolidation, the use of complete concrete encasement, and a 5-ft anchorage depth, total rotation of a pole at the ground line can be as low as approximately 3×10^{-6} radians per ft-lb of applied tilting moment for nominal 5-in.-top, pressure creosoted, Southern Pine poles in a 12-in.-diameter concrete anchorage. Approximately 3 percent of this total rotation will be non-recoverable because of plastic consolidation of soil. Approximately 50 percent will be caused by elastic consolidation.

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. . . Frequency Analysis

(Continued from page 225)

peak discharge corresponding to the estimated runoff volume, and *(d)* making frequency analysis of the estimated peak discharge. Fig. 3 shows a coaxial rainfall-runoff chart used in step *(b)*. This chart is developed from a study of the data from a number of past storms and runoff by means of a statistical correlation analysis (12). It provides a tool for estimating runoff volume in terms of inches of the depth over the basin from the reported storm rainfall, duration of storm, week of the year, and an index of antecedent precipitation. The index of antecedent precipitation is a measure of the moisture deficiency of the basin at the beginning of the storm. Entering the chart in Fig. 3 with applicable values of the four factors as indicated by the arrows gives an estimate of the volume of storm runoff data under the corresponding hydrograph.

Another method was developed by Langbein (13) of the U.S. Geological Survey. By this method, equivalent one-day rainfalls for the record storms are first determined by the use of the distribution graph. The equivalent one-day rainfall is defined as an equivalent depth of rainfall such that, if it fell in 24 hours it would produce a peak equal to that produced by the given rainstorm. In the meantime, the short-period peak discharge data are used to construct a chart as shown in Fig. 4(A), which represents the relationships among the equivalent one-day rainfall, the peak daily discharge, and the base-flow index. The base flow at the time of the peak discharge is taken as the base-flow index. This index is an expression of the antecedent soil conditions. By means of this chart, base-flow indices for the long-period rainfall record can be determined. It is assumed that two prominent factors that lead to a peak discharge are the storm rainfall and the antecedent conditions. It is therefore possible to construct a runoff probability curve of great recurrence interval by combining the frequencies of the two factors. For example, suppose there are 13 years of rainfall record which give 13 years each for the data of equivalent one-day rainfall and of base-flow index. The resulting synthetic runoff frequency data will be theoretically of 13 x 13, or 169 years. Fig. 4(B) shows the comparison between the 13-year observed runoff probabilities and the 169-year synthetic runoff probabilities for annual peak discharges on the Sepulga River.

As mentioned previously most runoff data agree satisfactorily with the recommended theoretical distribution laws. However, it occurs frequently that runoff data plotted on a probability paper do not exhibit a straight line trend but rather one that is better defined by either a curve or two or more straight lines (Fig. 5). An attempt to explain this phenomenon was first made by Hazen (14). He reasoned that the sample of the data was probably drawn from two or more populations each of which has a different character. With a similar reasoning, Potter (15) made an assumption for runoff data of small watershed that one population consists of those maximum peaks that occur most frequently but seldom produce appreciable flooding beyond the bank-full stage of the stream channel, while the other population consists of those less frequent events where considerable flooding takes place. Accordingly, available data were separated into two portions, and frequency and correlation analyses were made. Tentative conclusion of such study indicates that for small watersheds the assumption of one population of peaks would affect frequency analysis based on short records to a greater degree than when longer records are used. If this finding is generally true, runoff data from small watershed may not be considered as the representative sample from one population when the data indicate a distinct break on the probability curve. Consequently, separation of data into portions of several single populations would be necessary in the frequency analysis.

Conclusions

Owing to construction of numerous minor drainage structures on farm lands and along highways and to accumulation of available data, there is a growing need of frequency analysis for the determination of design discharge from small watershed. The current practice of analysis is to select data as either the annual maximum values or the exceedance values. For annual maximum values, the extreme-value law and the log-probability law are most commonly used as the basis of theoretical distribution. For exceedance values, the exponential law is used. The recommended procedure of analysis is to plot the data on a probability paper and determine the frequency by the method of least squares. Since runoff data from small watershed are generally of short period of record, two methods based on the physical basin characteristics may be used for extending the frequency data beyond the period of record instead of the extrapolation practice. If the data do not exhibit a single straight-line trend on the probability paper, a tentative study has shown that they may comprise two or more populations, and consequently separation of populations would be considered in the frequency analysis.

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Development of the Tandem Tractor

In an effort to extend flexibility in farm power, provision has been made for combining two tractors as a single four-wheel drive unit or detaching for individual operation as the need exists

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RUBBER TIRES, variable-speed engines, quick attaching wheel weights, and expansions in gear ratios have all contributed to the extension of flexibility in farm tractor power, whereby power and weight can be varied to fit the load. Further flexibility has been gained in the recent development of the tandem tractor—an arrangement in which two tractors are hooked together and operated as a single unit from the seat of the rear tractor.

Together, the tractors can do jobs not economical for small or medium tractors (plowing, disking) with a 50 percent reduction in labor, and yet, when taken apart, can be used to do jobs not economical for large tractors (planting, cultivating, pulling wagons, and farm chores). For light loads, the individual tractors are cheaper to operate than a big tractor, have better fuel economy, are most maneuverable, and the initial cost is less. The tandem tractor can do jobs usually reserved for track-type tractors such as terracing and land leveling, and save the cost of hiring an earth moving tractor.

The tandem tractor provides an economical four-wheel drive tractor. The purchase price of two medium size gasoline tractors normally is lower than that for one conventional four-wheel diesel tractor of equivalent horsepower. Since each motor supplies power to a set of drive wheels, the relation of one set of drive wheels to the other drive wheels is completely flexible so that a torque wind-up caused by one set of drive wheels overriding the other set common to most four-wheel drives, is not a problem in tandem tractors.

Mounted equipment (cultivators and mowers) may be used on the individual tractor. Trailing implements, (disks, field cultivators and plows) with sufficient capacity are available for the tandem tractor.

Method of Joining Tractors

The tractors are located one directly behind the other and the front wheels of both tractors are removed. In steering the tandem tractor, the front tractor turns with respect to the rear tractor about a vertical king pin in a manner similar to a fifth wheel. The vertical king pin (Fig. 2) consists of a superstructure bolted to the front axle of the rear tractor and has a trailer hitch ball located above the radiator of the rear tractor and a bolt below the radiator. The king pin is inclined forward to assist the front tractor in maintaining a forward direction. The lowest energy level in the steering quadrant, thereby, is straight forward. Tilting the king pin may be compared to caster in the Ackerman steering system.

A bearing is located close behind the rear axle housing of the front tractor to permit rotation of one tractor about a longitudinal axis with respect to the other tractor. This articulation is needed when one wheel encounters a rock. The journal of the bearing (truck rear axle) lying in the horizontal plane (Fig. 2) is attached by a structural member to the three-point hitch system of the front tractor while the bearing housing is attached to the vertical king pin.

Control of Tractor

Each of the controls operate simultaneously on the front tractor when the driver activates the control on the rear tractor.

Clutch

The hydraulic system of the front tractor was used to control the front clutch. A hydraulic cylinder (attached to the clutch pedal of the front tractor) a relief valve, and a globe valve are placed in series. As long as the globe valve is open, oil circulates to sump. When the rear clutch pedal is depressed, the globe valve closes and the oil enters the hydraulic cylinder depressing the front clutch pedal. When the cylinder reaches the end of its stroke, the oil flows through the relief valve returning to the sump.

Steering

The tandem tractor is steered by using two long single-acting hydraulic cylinders located under the rear tractor (Fig. 2). One end of each cylinder is hooked to the swinging drawbar bracket of the rear tractor and the other ends of the cylinders are hooked to each side of the drawbar of the front tractor. A hydraulic pump (front-mounted manure loader pump located on rear tractor) is used to operate the hydraulic cylinders. A four-way valve attached to the steering wheel of the rear tractor controls the steering cylinders. A follow-up rod is hooked between the top link of the front tractor and the valve control lever. This rod (Fig. 1) provides "feel" and precision control of the turning movement by giving a controlled relationship between rotation of the steering wheel and degree of turn at the king pin.

Throttle

The speed of the engines are synchronized by connecting a vacuum operated diaphragm to the front governor control rod. The diaphragm is connected to the intake manifolds of the front and rear tractor and operates in a manner to equalize the vacuum in the manifolds by loading or unloading the governor of the front tractor.

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Fig. 1 Tandem tractor developed at Iowa State College in 1956, consisting of a Model 8N Ford tractor leading a Ford Model 860

Ignition

A jumper wire was hooked between the rear and front ignition coils. Turning on the key of the rear tractor made both tractors operative; turning it off, killed both motors.

Advantages

Four-Wheel Drive — In wet spots and on sandy soils, the four-wheel drive is superior to the two-wheel drive because, when one wheel slips, the other three wheels still have traction. Under heavy load, the four-wheel drive develops maximum drawbar pull without undue slippage. Compared with a two-wheel drive, the four-wheel drive reduces the tire size (width) and weight needed to develop full horsepower of the tractor. The tracking of the rear wheels in the tracks of front tractor reduces the power required in soft fields.

The characteristics of the four-wheel drive when turning under load improved the handling of drawn implements (disks and plows). The four-wheel drive provides a positive non-slip turn; *i.e.*, differential brakes are not required for making a close turn under load.

The weight distribution of the tandem tractor is good. Table 1 gives weight distribution with five-bottom plow in lowered and raised positions.

TABLE 1. WEIGHT AND WEIGHT DISTRIBUTION OF MODEL 860 FORD TANDEM TRACTOR*

	FRONT WHEELS		REAR WHEELS	
	Weight pounds	Weight distribution percent	Weight pounds	Weight distribution percent
Plow lowered †	5680	62.9	3355	37.1
Plow raised	4758	46.1	5586	53.9
20% weight shift and plow lowered	3872	42.9	5163	57.1

*Weight of tandem tractor was 9035 lb.
†Weight of five-bottom plow was 1310 lb.

Dynamometer Tests — A preliminary dynamometer test was conducted with the tandem tractor (Fig. 4) on a loose cinder track with the tractors joined. Drawbar pull and speed were determined with only one tractor pulling at a time and then with both tractors pulling together.

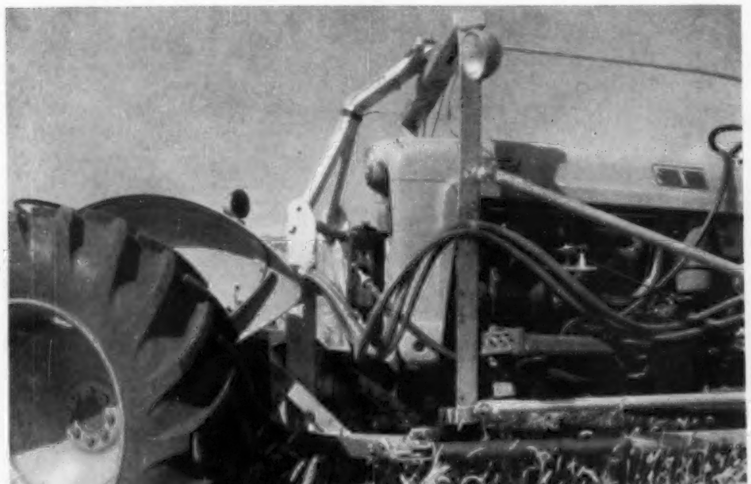

Fig. 2 View of the superstructure which incorporated the forward tilting king pin, the horizontal king pin and left hydraulic steering cylinder

Fig. 3 Rear view of the tandem tractor opening a field with a five 16-in bottom, rear-mounted plow

. . . Tandem Tractor

TABLE 2. PRELIMINARY DYNAMOMETER TEST OF A TANDEM TRACTOR COMPOSED OF A MODEL 8N FORD AND A MODEL 860 FORD TRACTOR

	Drawbar pull of tractor pounds	Power developed by tractors horsepower
Front tractor, Model 8N, 3rd gear	1180	12.9
Rear tractor, Model 860, 2nd gear	1380	12.1
Sum of tractors pulling separately	2560	25.0
Pulling as a tandem tractor	3450	28.2

The above data indicate that a tandem tractor is capable of pulling more load on a loose cinder track than the sum of the pulling effort of the two tractors pulling individually. The reason for this is, *(a)* force required to push front wheel is gained for drawbar pull and *(b)* the weight of the tractor is concentrated on the drive wheels. Because of the loose condition of the track, the dynamometer tests were discontinued. Additional dynamometer tests will be required to completely determine the performance of the tandem tractors.

Power Take-Off — Two tractors hooked in tandem can provide a completely flexible constant running power take-off. When pulling PTO-operated machinery, the front tractor is placed in gear. The PTO shaft of the machine is hooked to the rear tractor. The forward speed of the tractor is regulated by manually controlling the throttle of the front tractor while the PTO speed of the machinery is controlled by the throttle on the rear tractor.

Use of an overrunning PTO clutch permits the rear tractor to be placed in a lower gear than the front tractor. With this arrangement the rear tractor can take some of the load and help move through wet spots when the front tractor begins to slip or mire.

Wheel Spacing — Tractors with power adjusted tread combine to provide a tandem tractor with power adjustment of all four wheels.

Field Operation — In order to test the tandem tractor in the field, a five-bottom plow (Fig. 3) was built by adding two bottoms to a regular three-bottom mounted plow. The three-point hitch superstructure was relocated so that the plow would be in correct operating position with a 76-in. wheel spacing. The 76-in. wheel spacing permitted the tractors to be separated and used for cultivating corn without changing the wheel spacing. The center of draft was almost directly behind the center of pull. Rear mounted manure loader booster cylinders were mounted in parallel with the 3-point hitch system to assist in raising and controlling the mounted plow.

The tandem tractor (two Model 860 Fords) pulled the five-bottom (16-in.) plow in dry Webster-Clarion soil at a speed of 6 mph (4th gear). This speed proved to be too fast for good coverage of stubble, but at 4 mph (3rd gear—part throttle) good coverage was secured. Wheel slippage was not noticeable. It was observed that the rear wheels were actually geared to the tracks of the front wheels.

The width of the headlands did not have to be widened when the tandem tractor was used. The turning characteristics of the center-hinge steering of the tractor made it possible to plow to the headland and drop the plow after the headland is cleared when entering the field.

Disadvantages

Coupling — The time required for coupling and uncoupling is a disadvantage. Improved design, quick-attaching self-sealing hydraulic and electrical coupling will speed the operation.

Ties Up Small Tractors — While the tractors are coupled together jobs requiring single tractors may be delayed. This will call for advance planning to do the heavy jobs while the tractors are together and light jobs while apart.

(Continued on page 236)

Fig. 4 Tandem tractor under test on a cinder track using dynamometer cart and loading tractor and pulling another tractor for additional load

Machine Laying of Polyethylene Mulch

W. H. Hessenthaler
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New mulching attachment makes the laying of mulch film an easy matter, even during windy weather

A SIGNIFICANT advance in the field of mulching was achieved recently at the Kentucky Agricultural Experiment Station with the successful testing of a black polyethylene mulch. Through use of this mulch, beans and tomatoes were produced two to ten weeks earlier and a marked increase in total yield was reported. Even more important, the quality of the produce was notably improved. This was due to the greater and more even moisture supplies as well as a larger amount of nutrient obtained with less leaching and packing of the soil under the mulch. Also contributing to this increase in quality was the reduction in disease, spotting and cracking of the fruits and pods. The suppression of weeds around the plants was another feature observed by the experiment station.

After such successful results, it was anticipated that requests for an improved method of installation would accompany the increased demand for plastic mulch.

To date the installation of most polyethylene mulch film has entailed slow and expensive hand-labor techniques, which proved an almost impossible task on windy days. The logical solution to this problem is mechanization of the film-laying process. One or two partially successful attempts have been made by individuals in the field to develop some mechanical means for laying the mulch film. However, thus far no implement is commercially available for general farm use.

Recognizing the necessity for devising a practical method of installation, an adjustable demonstration model of an implement was developed that will mechanically lay mulch film of any width, even during windy weather. This implement has been so designed that it can be built by using a number of parts from conventional farm cultivating equipment. This will allow many farmers to convert their present cultivators into mulch-laying implements.

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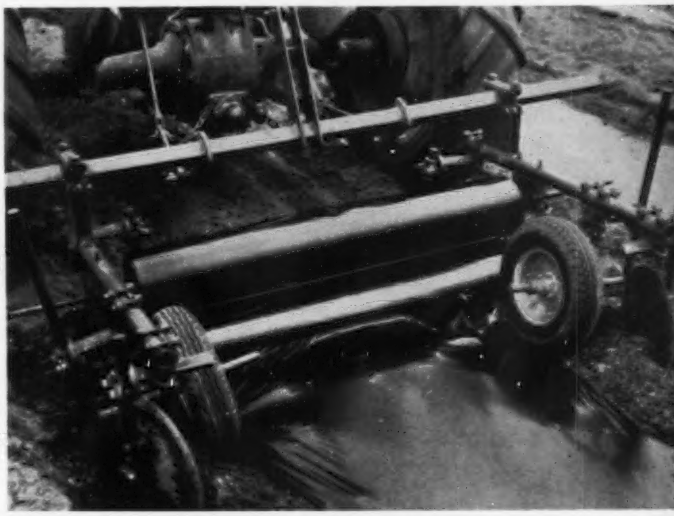

Fig. 1 Close-up of "mulcher" in action. Note that the wheels are set at a slight angle to prevent rubber tires from cutting the thin film while pressing it into the furrow

Design of Implement

For the construction of the demonstration equipment, parts of a rear-mounted two-row cultivator were chosen. This decision was influenced by the particular frame work of this cultivator. The tool bar of this machine fits the standard three-point hitch of several makes of farm tractors, and the mulch implement can be raised or lowered by the hydraulic system of the tractor. The mulching gear is carried in the raised position when the tractor is turned at the end of a row. When mulching is started at the head of a row, it is lowered onto the soil.

The framework of the implement consists of an 84-in. tool bar, two "long rigs" (coupling plate plus 37-in. beam), four disks, a film handling unit, a pressure roller and two rubber-tired wheels. The "long rigs" are attached to the tool bar and are adjustable to any width depending on the crops to be mulched or the width of the available film. Film up to 6 ft wide can be handled with the 84-in tool bar; however, the most commonly used film for mulching is usually 4 ft wide. The four disks are attached to the beam by means of clamps and crossheads. Two disks are located in the front and two in the rear. These are so arranged that the front disks will open a small furrow into which the edges of the film are pressed by the wheels. They are set at a slight angle to prevent the rubber tires from cutting the thin 1½-mil film while pressing it into the furrow. The rear disks will then move the soil back over the edges of the film so as to keep the film firmly in place. The film is pressed to the soil by a steel pressure roller as the film unwinds from the film-handling unit. This unit consists of a shaft on which the film cores are held by means of two core plugs. The shaft is attached to the lower side of the beam immediately behind the coupling plate by means of two pillow-block bearings. The film-handling unit should be kept as close to the soil as possible, so that the wind cannot exert any

great force on the film between the roll and the pressure rollers, and so unwind the film. A belt brake attached to the shaft will control the unwind speed. The pressure roller should press the film to the soil at a point slightly behind the film roll, but far enough in front of the rubber tires so that no contact can be made between the roller and the tires. This would cause a brake action resulting in unsatisfactory unwinding of the film. For this reason the swivel point of the attachment bar for the pressure roller was brought forward.

Operation

With minor changes on the demonstration equipment, one-man operation is possible. With the "mulcher" in the raised position, the film is brought back behind the rear disks so that it passes underneath the pressure roller and rubber tires. The implement then is lowered onto the film. The first foot of film is covered manually with soil to anchor it firmly in the ground. The film is then laid mechanically over the whole row and is cut at the end of the row. A full roll of polyethylene film is always carried on the tractor so that an empty core can be replaced anywhere along the row. To accomplish this, film from the full roll is overlapped over the last two feet of the laid film while the implement is in the raised position. It is then lowered slowly onto the film. The overlapped film is then anchored manually, and the mulching operation can be resumed. Replacing of a roll of film requires approximately three to four minutes. However, with modifications in the film handling system, this time can be cut in half.

Application

This mulch-laying equipment has been used successfully on a seven-acre field of sandy loam soil to lay 4-ft-wide film on 7-ft center at a rate of more than one acre per hour. The film was laid during windy weather, but no difficulties were experienced during or after the mulching operation. Tomatoes and melons were planted through this mulch and no dislocation or loosening of the film was reported during or following the operation.

The simple design is of practical advantage to farmers mechanically inclined. This feature will permit them to assemble their own mulching equipment from suitable cultivators until such time as "mulchers" are sold commercially.

. . . Grape Harvester

(Continued from page 221)

Energy Requirements — All harvester components were powered, either directly or indirectly, with hydraulic motors. This energy source not only provided flexibility of operation but also made energy analysis simple. Motor performance data are shown in Table 1. Of special interest is the difference in horsepower requirement between the sickle cutter bar and the saw-chain unit. The advantage of the saw chain over the sickle was its stability in cutting efficiency as ground speeds increased. Conversely, the sickle cutter possessed the distinctive advantage of not stalling when obstructions were met.

The internal tractor hydraulic system provided oil to two hydraulic motors (continuous operation) and all the cylinders (Fig. 10). The front-mounted pump operated cutter bar and blower. The temperature rise of the oil with respect to time is shown in Fig. 11.

Field Performance — The design speed was 1.5 mph. This harvest rate would yield 14 acres of raisins or 17 acres of wine grapes per day. Using one driver-operator, a manpower advantage (6, 7) of 70:1 and 63:1, respectively, was calculated when comparing machine harvest to hand harvest. Because of the steering problem, and also because of cutter inefficiency, a ground speed of 0.5 mph was used for most of the 1957 trials. The maximum speed used was 1.6 mph. Performance of the 1957 harvester proved that it was capable of commercial harvests.

Future — Further research will be directed toward improving cutter-bar efficiency, trash removal, tractor guidance, and vine breeding-training.

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5 Lamouria, Lloyd H. Progress report: on machine picking of grapes. Western Fruit Grower, 51(11):26, November, 1954.

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. . . Tandem Tractor

(Continued from page 234)

Tractors May Be Overloaded — Because the four-wheel drive places all the weight on the drive wheels, the drive wheels do not function effectively as slip clutches, as a result, excessively high torques may develop in the rear axle shaft.

Summary

A tandem tractor was constructed to test the basic concept of a flexible powered tractor — that the power and weight of a tractor can be varied according to the size of the load. The tandem tractor provides a large tractor for the heavy work by combining two small or medium-sized tractors which can be quickly uncoupled into regular tractors.

The front tractor (all front wheels of both tractors are removed) is turned by hydraulic cylinders about a tilted king pin located above and below the radiator of the rear tractor. A longitudinal pivot was located between the two tractors and attached to the three-point linkage of the front tractor.

Controls were developed for simultaneous operation of the clutch, ignition and throttle from the seat of the rear tractor.

Dynamometer tests and field tests indicate the superiority of the four-wheel drive over the conventional two-wheel drive. The tandem tractor is a versatile and economical system for pulling both large and small loads.

ASAE Officers for 1958-59

The following new officers of the American Society of Agricultural Engineers were elected as a result of the regular election conducted by letter ballot of its corporate members, and will take office at the close of the Society's annual meeting to be held on the Santa Barbara Campus of the University of California, June 22-25:

President—E. G. McKibben, director of the Agricultural Engineering Research Div., (ARS), USDA, Hyattsville, Md.

Vice-President—J. W. Borden, vice-president of sales, Eversman Mfg. Co., Denver, Colo.

Councilor — H. H. Nuernberger, head, agricultural section, Development Div. of the Aluminum Co. of America, New Kensington, Pa.

Nominating Committee — S. S. DeForest (chairman), engineering editor, *Successful Farming*, Meredith Publishing Co., Des Moines, Iowa; J. R. Carreker, agricultural engineer, (SWCRD, ARS), USDA, and agricultural engineering dept., University of Georgia; N. H. Curry, professor of agricultural engineering, Iowa State College; J. Roberts, chairman, agricultural engineering dept., State College of Washington; and C. L. Zink, product research dept., Deere & Company, Moline, Ill.

The members of the Council for the Society year of 1958-59 will include the above newly-elected officers together with the following: Earl D. Anderson and Roy Bainer, past-presidents; W. J. Ridout, Jr. and L. W. Hurlbut, vice-presidents; and G. E. Henderson and D. C. Sprague, councilors.

Members of the Society are invited to send to any member of the Nominating Committee such suggestions as they may have for nominees for election of officers of the Society in the next annual election of officers which will be held early in 1959. It is desirable that such suggestions reach the Nominating Committee on or before June 1, 1958.

Dr. McKibben Honored

Word has been received from Harald A. Moberg, director of the Swedish Government Agricultural Machinery Testing Institute, Uppsala, Sweden, that Dr. Eugene G. McKibben, director of the Agricultural Engineering Research Division (ARS), USDA, has been elected a member of the Royal Academy of Agriculture and Forestry in Sweden. Further details concerning presentation were not reported.

Dr. McKibben has been elected as next president of ASAE, and will take office in June at the Annual Meeting in Santa Barbara, Calif.

AE Program Reinstated at Utah State University

D. F. Peterson, Jr., dean, College of Engineering and Technology, Utah State University, has reported that the agricultural engineering program at Utah State University is being reinstated and will be administered under the direction of Cleve H. Milligan, head of the civil engineering dept. A B.S. degree in agricultural engineering will be offered with emphasis on soil and water conservation.

Details for Annual Meeting Extension Exhibits

The Extension Committee is planning to make the ASAE 51st Annual Meeting to be held June 22 to 25 at the University of California, Santa Barbara College, outstanding with respect to exhibits.

The exhibit classes include publications, demonstration models, movies, radio and television slides and film strips, extension methods or recipes, and textbooks. Blue ribbons will be awarded winners in all classes except textbooks. Industry groups will not compete against the public agency groups and vice versa.

Publications: Included in this entry will be bulletins and periodicals and these will be separated into industrial and public agency classes. Each ASAE member may enter one bulletin and/or one periodical. Write for an application blank to Donald W. Derber, agricultural extension section, U.S. Steel Corp., 2831-525 William Penn Pl., Pittsburgh 30, Pa.

Demonstration models are to "show developments having engineering implications relating to agriculture, the primary objective of which is the education of the viewer." Classes will be provided for public agency and industrial groups. Rules and regulations for entry of demonstration models may be obtained from R. G. Curley, extension agricultural engineer, agricultural engineering dept., University of California, Davis.

Movie awards will be made in two classes, those prepared by industrial or commercial organizations, and those developed by colleges, universities and other public agency groups. Any group or any individual who has developed a movie during the past year is eligible to enter competition for this blue ribbon by writing B. P. Hess, Westinghouse Electric Corp., Dept. 10-L, East Pittsburgh, Pa.

Radio and TV Exhibits: Any charts, photographs, slides and other specimen used in the preparation of television and radio materials that might make interesting exhibits for ASAE can be entered by writing for an application form from Donald Brown, extension agricultural engineer, Michigan State University, East Lansing.

Slides and Film Strips are some of the most effective teaching aids in extension programs. A set of slides or film strips showing agricultural engineering developments or how to teach some phase of agricultural engineering may be submitted. There are two classes, one for industrial and commercial groups and one for the public agency group. For applications on slides and film strips write to W. T. Welchert, extension agricultural engineer, University of Arizona, Tucson.

Extension Methods and Recipes: This phase of the exhibits gives the extension agricultural engineer an opportunity to swap ideas on how best to carry out certain jobs connected with his work. Write Leo T. Wendling, extension agricultural engineer, Kansas State College, Manhattan, for an application.

Textbooks are not judged or ribbons awarded but it provides an opportunity to see what is new in the textbooks field and also gives the authors and publishers an opportunity to display their publications. If any new textbooks have been produced during this year the committee would like to have them entered. Applications may be sent to J. P. Schaenzer, 1116 S. 28th St., Arlington 6, Va.

Contractor Business Seminars

A series of business seminars will be conducted in half-day sessions at Caterpillar Dealerships throughout the country in 1958. The seminars are designed to more fully acquaint the normally small contractors with sound business practices, and are aimed at counteracting the major causes of contractor failure.

Subjects to be covered will include machinery owning and operating costs, machine operation and application, production comparisons, service, parts, advertising and job opportunities. Management practices including business records, owning and operating costs and bidding methods will be discussed.

Nuclear Energy for Industry

The third annual summer program in Nuclear Energy for Industry will be held on the Berkeley campus of the University of California during the months of June, July and August.

A nine-week Nuclear Engineering short course for engineers and other technical personnel begins June 16. A Nuclear Engineering survey program to acquaint executives and administrators with the nontechnical aspects of nuclear science, and show how it can be applied in industry, will be given during the week of July 7.

Further information and application for enrollment may be obtained from Engineering and Sciences Extension, Room 100, Building T-11, University of California, Berkeley 4, Calif.

ASAE MEETINGS CALENDAR

April 17-18 — ALABAMA SECTION, Whitley Hotel, Montgomery, Ala.

April 18—MICHIGAN SECTION, Howell Boy Scout Camp, Brighton, Mich.

April 24-25—PENNSYLVANIA SECTION, Pennsylvania State University, University Park, Pa.

April 25—QUAD CITY SECTION, Izaak Walton Club, Clinton, Iowa

April 25-26 — FLORIDA SECTION, Jacksonville, Fla.

May 2-3 — OHIO SECTION, Ohio State University, Columbus, Ohio

May 16 — IOWA SECTION, place not announced.

May 22 — MINNESOTA SECTION, Dyckman Hotel, Minneapolis, Minn.

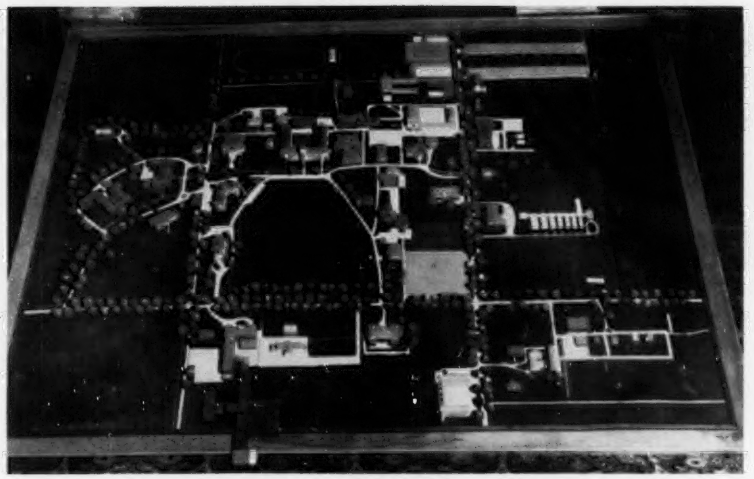
June 22-25 — 51st Annual Meeting, Santa Barbara Campus, University of California, Santa Barbara, Calif.

August 25-27—NORTH ATLANTIC SECTION, Guelph, Ontario, Canada.

October 22-25 — PACIFIC NORTHWEST SECTION, Oregon State College, Corvallis, Ore.

December 17-19 — WINTER MEETING, Palmer House, Chicago, Ill.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.



Model plan of the Ontario Agricultural College in Guelph, scene of the North Atlantic Section meeting to be held August 25 to 27.

Michigan Section

The Michigan Section held a meeting in the Executive Conference Room, Central Staff Building of the Ford Motor Co. in Dearborn on February 15. The morning session was devoted to papers on sprinkler irrigation, agricultural watershed studies, a soil value system for agriculture and dynamic tractor stability.

The theme for the afternoon session was on the training of engineers by industry. K. B. McEachron, Jr., dean of instruction, Case Institute of Technology, led the discussion by first presenting his own viewpoints on trends in engineering education. Others appearing on the program were J. R. Schram, Tractor and Implement Division, Ford Motor Co.; N. H. Mitchell, Aerovent Fan & Equipment Co.; J. P. Carr, John Bean Division, Food Machinery & Chemical Corp.; E. L. Yates, director, technical personnel relationships, General Motors Corp.; and W. J. Friess, supervisor of program development, education department, AC Spark Plug Division, General Motors Corp.

The spring meeting and ladies night will be held at the Howell Boy Scout Camp, Brighton, Mich., on April 18. The meeting will begin with dinner at 6:30 p.m. Earl Anderson, ASAE national president, will be the principal speaker. Installation of section officers, entertainment and square dancing will complete the evening.

North Carolina Section

The North Carolina Section held a meeting on February 18 in the new agricultural engineering building on the campus of North Carolina State College, Raleigh.

The morning opened with a paper on research develops a new farm construction technique, by Robert G. Bass, Portland Cement Assn., Richmond, Va. Following a short recess papers related to research work in tobacco were presented by W. C. Splinter and C. W. Suggs; and F. J. Hassler, W. H. Johnson and W. H. Henson. Two other papers, "Land Forming in Eastern Virginia," by Phelps Walker, and "Under-Floor Heat for Poultry Brooding," by H. R. McCray, were also given during the morning session.

The program for the afternoon was devoted to talks on food processing technology, by Harold Bland; one-man hay baling system, by R. M. Merrill, Deere and Co., Moline, Ill., and guides to better home lighting, by Betsey Doughton.

During the business meeting new officers for the following year were elected. Chairman, William C. Splinter; 1st vice-chairman, Charles Overman; 2nd vice-chairman, Howard Ellis; and secretary-treasurer, W. T. Mills.

North Atlantic Section

The North Atlantic Section meeting will be held August 25-27 at the Ontario Agricultural College in Guelph, Ontario, Canada. The general program will begin Monday morning, August 25, with a theme on applications of radioactive elements to agriculture. There will be speakers on tracers to detect wear in motors, radiation for food preservation and insect killing by radiation. The afternoon session will include two concurrent programs. The joint session of Farm Structures Division and Electric Power and Processing Division with a theme on specialized materials handling problems associated with dairy operations will cover subjects on the development of bulk feed handling, handling and storing manure in loose housing systems, and mechanical removal of silage from horizontal silos. The joint session of Soil and Water Division and Power and Machinery Division will include topics on land-leveling vs. flotation, physical processing and plowed soil for row crops, air-cooled diesel engines, and the slippage factor in soil compaction. Monday evening a trip to the Shakespearean Festival will follow a barbecue.

Tuesday morning, August 26, four concurrent sessions are scheduled. The Power and Machinery Division program will be devoted to four papers on the application of petroleum fuels and lubricants to agricultural machinery, the progress in hay crushing developments, the future of hydraulics in agriculture, and the progress in design of equipment. The Soil and Water Division meeting will consist of talks on farm organizations look at Soil and Water problems, development and use of drainage guides, flood routing for large pond design, and watershed evaluation.

(Continued on page 245)

(Above) K. B. McEachron, Jr., dean of instruction, Case Institute of Technology, chats with some of the Michigan Section officers and speakers at a Section meeting February 15. *(Left to right)* E. D. Anderson, ASAE president; J. P. Carr, Section vice-chairman; N. H. Mitchell, Section chairman; E. L. Yates, General Motors Corp.; Dean McEachron; and T. F. Rice, Section vice-chairman. Speaker at right is W. J. Friess, supervisor of program development, education department, AC Spark Plug Div., General Motors Corp., who spoke on the creative engineering training program

(Right) Newly elected officers of the North Carolina Section. *(Left to right)* Charles Overman, 1st vice-chairman; W. C. Splinter, chairman; W. T. Mills, secretary-treasurer

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For more facts circle No. 52 on reply card

Scene of 51st Annual ASAE Meeting, June 22 - 25

Members of the Pacific Coast Section, hosts for the 51st annual ASAE meeting, June 22-25, are laying plans for a strong technical program combined with an excellent opportunity for vacationing in the West.

The Santa Barbara College campus of the University of California, situated on a 408-acre ocean front site, is itself a scenic attraction. The Santa Ynez mountain range rises as a backdrop behind the campus, and the seaward view is the open Pacific with the distant shapes of the Channel Islands off the coast. Campus recreational facilities enhanced by the mild summer climate of the California coastal area include a pool as well as beaches for swimming and sun bathing.

A broad program of interest to all agricultural engineers is shaping up, reports James R. Tavernetti, of the University of California at Davis.

Some of the highlights of the program include a Sunday night opening get-together and buffet dinner; all-day meetings on Monday of the ASAE divisions, student branch and public lands and public works group; division meetings again Tuesday morning; agricultural engineering tours of the area Tuesday afternoon, covering interests of all divisions; a Spanish barbecue Tuesday night, off the campus; division sessions again Wednesday morning; general session of the Society Wednesday afternoon; and the annual dinner Wednesday night. The public lands and public works program will continue through Thursday.

Mason Vaugh has accepted an assignment as executive secretary of the Laymen's Committee on Economic Life and Worldwide Christian Community, an interdenominational committee to promote industrial development in underdeveloped countries. He will continue as a representative of the work at Allahabad Agricultural Institute from which he retired in April 1957 as professor of agricultural engineering. Since 1921 he has been associated with mission work in India, and with the active management and development of the Allahabad Institute.

•

John M. Johnson has accepted the position of head of the extension agricultural engineering dept. of the University of Tennessee. He was formerly employed by the Moore Dry Kiln Co., Jacksonville, Fla.

•

Allen J. Moe, formerly a designer with the Minneapolis-Moline Co., has accepted a position as applications engineer with Perfect Circle Corp. in Hagerstown, Ind.

•

Cortland O. Haupt, formerly design engineer with Minneapolis-Moline Co., has joined the engineering staff of the Farmhand Co., Hopkins, Minn., as project engineer.

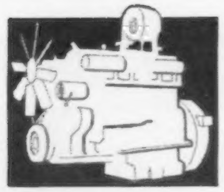
•

Robert C. Lieu, research fellow in farm structures at the University of Minnesota for the past 5 years, has accepted a position as research engineer with the Agricultural Research Service, USDA, Beltsville, Md. He will work under Wallace Ashby on the problem of environmental factors affecting farm structures.

NECROLOGY

Lonnie J. Kallaus, chief, engineering specifications section, International Harvester Co., East Moline Works, died February 28 after an extended illness. He has worked for International Harvester Co. for the past 22 years. He was also the owner of the La-Fonda Motel at Davenport, Iowa. He joined ASAE in 1956.

J. R. Dodson, product manager, irrigation, Northeast District, Olin Mathieson Chemical Corp., died of a heart attack on October 31, 1957. He joined the Company in 1951. Prior to that he spent some time in the U.S. Navy as an aviation parts specialist, and later was self-employed as a heating and plumbing contractor. He is survived by his wife and three daughters. Mr. Dodson joined ASAE in 1954.



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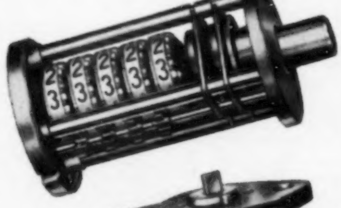

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For more facts circle No. 54 on reply card

MANUFACTURERS' LITERATURE

The Michigan Line

Clark Equipment Co., Construction Machinery Div.—Bulletin 150 describes and illustrates tractor shovels, dozers, scrapers, loggers, and excavator-cranes. It also explains a power train package engineered and manufactured by the company.

(For more facts circle No. 27 on reply card)

Acid-Resistant Lab Ware

General Scientific Equipment Co.—A 16-page illustrated catalog covering polyethylene and nylon products not affected by concentrated acids, oxidizing agents, hydroxides and polar liquids for laboratory ware.

(For more facts circle No. 28 on reply card)

Farm Equipment

New Idea Farm Equipment Co.—Two brochures covering the line of farm equipment manufactured by New Idea. Brochure 58485-12 describes and illustrates the company's different types of rakes, mowers, fertilizer spreaders, transplanters, loaders, manure spreaders, corn pickers and wagons.

Bulletin 5775-5 explains the No. 400 pull type parallel bar rake. Specifications and a comparison chart are included.

(For more facts circle No. 29 on reply card)

Products of Atlas

Atlas Powder Co.—A 14-page booklet which describes the company, its major product lines, and the fields in which they are used. Some of the products covered are explosives, chemicals, food ingredients, and activated carbons.

(For more facts circle No. 30 on reply card)

Power Steering Booster

Behlen Mfg. Co.—A 4-page information sheet containing cross sectional drawings and parts listings on the power steering booster unit. The unit is especially designed for installation on tractors on the farm, as well as graders, cranes and other heavy equipment.

(For more facts circle No. 31 on reply card)

Feedlot Improvements

Portland Cement Assn.—A 16-page booklet prepared for the cattle feeder showing some improvements for cattle feedlots. Feedlot planning, construction of pens, alleys, troughs, water tanks, ramps, chutes and other operational facilities are described. Photographs and drawings are included.

(For more facts circle No. 32 on reply card)

Small Watershed Program

Caterpillar Tractor Co.—Form D809 is an illustrated brochure pointing out progress of the Federal Watershed Protection and Flood Prevention Act and its effect on watershed projects approved for construction in more than 30 states. Watershed jobs in Texas, Nebraska, Iowa, Delaware, Kentucky and Oklahoma are pictured and described.

(For more facts circle No. 33 on reply card)

Centrifugal Castings

American Brake Shoe Co., National Bearing Division—Booklet, 10M-58, discusses centrifugal castings of bronze and copper parts for a wide range of applications. It includes a description of the technique, a complete chart showing alloys available with their specific characteristics, illustrations of typical castings, facilities and engineering services.

(For more facts circle No. 34 on reply card)

Irrigation Pumps

Marlow Pumps Div., Bell & Gossett Co. —This bulletin I-57 contains information on the line of the company's irrigation pumps. These pumps are designed for irrigation applications and are supplied complete with power units. Specification charts are included and the different models are illustrated.

(For more facts circle No. 35 on reply card)

Plywood Catalog

Douglas Fir Plywood Assn. — A three-part, 20-page catalog which presents basic information on fir plywood standard grades and specialty products for architects, engineers, builders, product design engineers, and building code officials. It contains tables and illustrations of products and applications.

(For more facts circle No. 36 on reply card)

Anti-Corrosion Coating

Niphos Process Division, Tube Reducing Corp.—A 4-page brochure describing the "Niphos" process which is reported to give resistance to corrosion for any mild steel. The process is defined from the standpoint of its alloy-bond nature, its application and its advantages of protection, abrasion resistance, versatility, ductility and weldability.

(For more facts circle No. 37 on reply card)

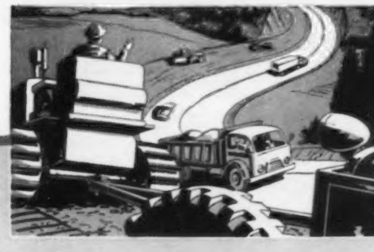
Steel Building Booklets

Wonder Building Corp. of America—Two booklets describing the company's all-steel building units. One booklet entitled "All-Steel Structures for Profitable Farming," illustrates and discusses farm structures. The other entitled "Truss-Skin Roof System," shows applications in many types of clear-span buildings.

(For more facts circle No. 38 on reply card)

BLOOD BROTHERS Universal Joints

"get the power through" to make our highways come sooner . . .



It's a rough, tough, shock-and-strain life for the average 'dozer and loader. But machines like these are ready for it. Part by part, they've had long life engineered right in from the start.

Blood Brothers Universal Joints, for example, are one of the rugged, dependable components you'll find . . . selected for their field-proved ability to withstand punishment.

On these machines—and many other kinds of road-building equipment —Blood Brothers Universal Joints "get the power through" dependably. It's one of their vital functions to help make our highways come sooner.

If you build heavy-duty equipment, write for Bulletin 557—or call on our engineers for suggestions.

ROCKWELL SRA

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Blood Brothers Machine Division

ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

For more facts circle No. 53 on reply card

Following are brief reviews of papers presented at ASAE meetings or other agricultural engineering papers of which complete copies are available. Information concerning copies of these papers may be obtained by writing to the American Society of Agricultural Engineers, St. Joseph, Mich.

Machine and Method Efficiency in Combining Wheat, by W. H. Johnson, assistant professor of agricultural engineering, Ohio State University. Paper presented at the Winter Meeting of ASAE in Chicago, Ill., December, 1957, on a program arranged by the Power and Machinery Division. Paper No. **57-516.**

The study, presented in this paper, determined the method and combine efficiency at various dates and moisture contents in soft red winter wheat. Throughout the study certain characteristics of the harvest became apparent. The condition and quality of the resulting grain was determined.

The standing grain as well as combined samples were followed throughout the season for moisture content, test weight, germination, dry matter loss, and kernel damage. Combine efficiency tests were made at various grain moisture contents between 28 and 12 percent. The combine method of harvest was also evaluated in this same range. Machine and harvest efficiencies are discussed.

Milk 60 Cows per Hour with the Herringbone System, by Roger M. Cleveland, manager, farm buildings division, Farmer Feeder Co., Cambridge City, Ind. Paper presented at the Winter Meeting of ASAE in Chicago, Ill., December, 1957, on a program arranged by the Farm Structures Division. Paper No. **57-563.**

This paper describes and discusses the herringbone system of milking cows. This program is said to require a completely integrated system of equipment and building. The herringbone system originated in New Zealand and the name came from the method of packing cows closely together at a 30-deg. angle from pit area.

Advantages of this system are listed as follows: Reduces labor, milk production increased due to handling in groups and packing, and the original cost has been reduced by utilization of less floor area and simpler equipment.

Mechanized Soil Sampler with Offset Drive, by M. E. Jensen, W. H. Sletten and R. L. Ochs, respectively, agricultural engineers and agricultural engineer (student trainee), SWCRD, ARS, Southern Great Plains Field Station, Bushland, Texas. Paper presented at the Winter Meeting of ASAE in Chicago, Ill., December, 1957, on a program arranged by the Soil and Water Division. Paper No. **57-535.**

A commercially available soil and foundation exploration drill rig has been modified for obtaining soil samples in experimental plots without crop damage. This machine has reduced the manual labor requirement for obtaining soil-moisture samples. The mechanized sampler with the offset sampling attachment requires two to three men for most efficient operation. Modifications of the drill rig and appurtenant sampling tools are described in detail.

Fewer-Better Lubricants for Agricultural Equipment, by C. N. Hinkle, agricultural engineer, Standard Oil Co., Chicago, Ill. Paper presented at the Winter Meeting of ASAE in Chicago, Ill., December, 1957, on a program arranged by the Power and Machinery Division. Paper No. **57-504.**

Farmers of today own many different machines and often more than one tractor. They are interested in using improved products for servicing this equipment and they want to use the least number of products. By using one product for several machines, they are able to increase the volume required and thus take advantage of the lower cost offered by large volume purchases.

This paper reports that the petroleum industry can make special products for large volume direct shipments, but faces a distribution problem when trying to deliver special products to the farm. Engine tests on modern engines prove that many improvements have been made in petroleum products by the use of additives. The adoption of the A.P.I. Oil Service Classifications is an attempt by the petroleum industry and engine builders to supply the quality oil needed for the engine and operating conditions encountered.

It is reported that cooperation between the engine builder, educational institutions and the petroleum industry, is needed in promoting the use of the proper lubricants and better servicing practices for agricultural equipment.

. . . Section News

(Continued from page 238)

The Electric Power and Processing Division will present papers on quality control and evaluation of produce, flash or hydrocooling of truck garden crops, and wagon hay drying progress report. The theme of the Farm Structures Division program will be on structures for today's dairy farm and will consist of topics on design requirements for paving barnyards, the need for standards for the use of various building materials and combination of materials, experience with vertical and horizontal silos, and a new concept in the storage of shelled corn.

A general program on Tuesday afternoon will cover subjects on insurance against hunger, by E. G. McKibben, president-elect of ASAE; today's challenge in agricultural research, by M. A. Farrell, vice-president, Pennsylvania State University; and Canada's growth and position in world affairs, by W. M. Drummond, Canadian Government. A business meeting will follow the program and a banquet will be held in the evening.

Wednesday morning, August 27, the theme for the general program will be on an integrated program of forage handling for a year round livestock feeding program. K. L. Turk, head, animal husbandry dept. of Cornell University, will speak on the role of forage in our agricultural program now and in the future; and J. Robert McCalmont, USDA, will present a paper on harvesting, storing and preserving of grass silage.

Minnesota Section

The Minnesota Section will hold a meeting at the Dyckman Hotel in Minneapolis on May 22. An afternoon technical program is being planned and a dinner meeting will be held with Dr. O. B. Jesness, recently retired head of the agricultural economics dept. of the University of Minnesota, as the speaker. Officers for the coming year will also be installed.

The Section met March 13 at Napoleon's Cafe in St. Paul. Following a dinner and a brief business meeting papers were given by H. D. Haynes, Caterpillar Tractor Co., on the role of heavy equipment in agriculture, and by Glenn Blanchard, Rilco Laminated Products, Inc., on building with laminated wood structural members.

Iowa Section

The Iowa Section dinner meeting was held April 4 at Vic's Tally-Ho Restaurant, Des Moines, Iowa. The program included ASAE President Earl D. Anderson, director of agricultural extension, Stran-Steel Corp., who spoke on reducing the odds in farming; and Don K. Struthers, merchandising dept., Tractor and Implement Div., Ford Motor Co., who discussed design features of farm equipment as they apply to sales.

Tennessee Section

Members of the Tennessee Section in the Memphis area held a meeting March 1 at Hotel Chisca in Memphis, Tenn. The program opened with Bill B. Bryan, Arkansas Experiment Station, speaking on effects of irrigation on production costs and quality. What's new in farm tractors was discussed by Bob Dyer, sales manager, J. I. Case Co., Memphis, Tenn.; and James A. Neely, TVA, Jackson, Tenn., spoke on the handling and processing of crops on the farm. The program was concluded with a talk on the role of climatology in crop production by A. L. King, meteorologist, U. S. Weather Bureau, Memphis.

If you are not a member of the American Society of Agricultural Engineers and want (1) to subscribe* to AGRICULTURAL ENGINEERING or (2) to receive information about ASAE membership—or if you *are* a member of ASAE and want to propose the names of one or more prospective members — then simply fill out and mail the card at the right.

(*NOTE: A subscription to AGRICULTURAL ENGINEERING is included in the annual dues of each ASAE member.)

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☐ I want to receive AGRICULTURAL ENGINEERING regularly. Enter my subscription for one year ($5.00 in USA; $5.50 in Canada; $6.00 elsewhere). Payment is enclosed.

☐ I would like information about membership in the American Society of Agricultural Engineers, including an application form. (I understand that a subscription to AGRICULTURAL ENGINEERING and a copy of AGRICULTURAL ENGINEERS YEARBOOK are included in the annual dues of ASAE members.)

☐ I am an ASAE member and suggest that membership information, including application form, be sent to the name and address below. I can supply names of ________ more prospective members. My name is ________

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Our "Reader Information Service" clerks will see that your wants are promptly transmitted to sources of materials requested.

Kindly have mailed to me, without obligation, more information about items in this issue indicated by the numbers circled below:

APRIL 1958

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1	11	21	31	41	51	61	71	81	91
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3	13	23	33	43	53	63	73	83	93
4	14	24	34	44	54	64	74	84	94
5	15	25	35	45	55	65	75	85	95
6	16	26	36	46	56	66	76	86	96
7	17	27	37	47	57	67	77	87	97
8	18	28	38	48	58	68	78	88	98
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3	13	23	33	43	53	63	73	83	93
4	14	24	34	44	54	64	74	84	94
5	15	25	35	45	55	65	75	85	95
6	16	26	36	46	56	66	76	86	96
7	17	27	37	47	57	67	77	87	97
8	18	28	38	48	58	68	78	88	98
9	19	29	39	49	59	69	79	89	99
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Stran-Master all-steel pole-barn

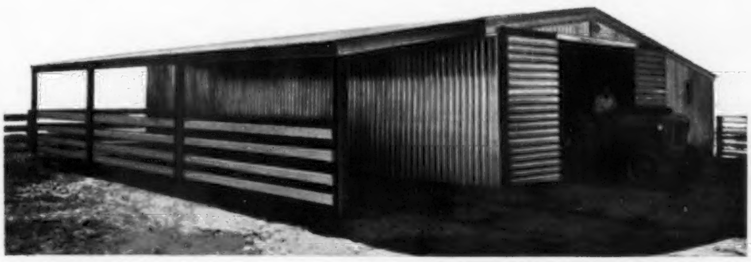
COSTS 30%-50% LESS THAN OTHER STEEL FARM BUILDINGS

For livestock housing:

Colorado dairyman claims this weather protection for his Holsteins greatly increased milk production. He has a 24′ x 96′ Stran-Master loafing barn with one side open. You can own a similar size for approximately $545 down.*

For machinery storage:

Indiana farmer enjoys easy access and plenty of space for machinery storage with repair center at left. He purchased a 48′ x 64′ Stran-Master. The same size costs you approximately $645 down.*



For multi-use:

Alabama owner combines totally enclosed machinery storage area with overhanging roof for livestock shelter. A 48′ x 48′ Stran-Master like this takes an initial investment of approximately $555 down.*

**F. O. B. factory for do-it-yourself construction.*

Now for a new low price, your farm can have all the benefits of permanent, firesafe buildings for your livestock and machinery. Mass-produced Stran-Master buildings are not only lower in cost, but give complete choice of size and layout!

Stran-Master buildings can be 12 to 120 feet wide, any multiple of 16 feet in length, with 10- or 14-foot eave heights. Buildings may be open, or partially or totally enclosed with heavy 26-gage galvanized wall and roof sheets. And all-steel pole-type construction is fast and simple. Do it yourself or have dealer's crew erect your Stran-Master.

Only one-fourth down buys a Stran-Master in just the size you want, yours to use and profit from while you take five years to pay the balance. Confidential financing arrangements between you and your Stran-Steel dealer leave your bank credit free for normal farm needs. See your Stran-Steel dealer now or mail the coupon for more information.

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Stran-Steel Corporation, Dept. 10-28
Detroit 29, Michigan

Rush the new Stran-Master catalog. I'm interested in a building approximately______ft. x ______ft. to be used mainly for______

Name______ ☐ Student

Address______

City, State______

For more facts circle No. 55 on reply card

RESEARCH NOTES

Brief news notes and reports on research activities of special agricultural-engineering interest are invited for publication under this heading. These may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Michigan.

Treatment of Surface Water

The U.S. Department of Agriculture has contracted with the Ohio Agricultural Experiment Station to study farmstead surface water supply installations to obtain information for use in developing effective and economical means for farm treatment of surface water for domestic use.

Dr. G. O. Schwab, professor of agricultural engineering at Ohio State University is in charge of the study. John W. Rockey of Livestock Engineering and Farm Structures Research Branch of USDA's Agricultural Research Service is the Department's representative for the project.

This study of selected farmsteads is the first step in developing recommended procedures for handling surface water supplies. The water supply installations will be examined to determine the effectiveness of filters, chlorinators, and/or other treatment equipment now being used on ponds, reservoirs, or other surface sources.

European Methods

Thayer Cleaver, USDA agricultural engineer, after attending the Oxford Farm Buildings Conference in England, visited many farms in England, Scotland, Sweden, Denmark, and the Netherlands.

He reports that one of the most valuable features of his trip was the opportunity to exchange ideas in person with all the people contacted in the various countries.

Mr. Cleaver brought back several plans and photographs of labor saving farm structures that he feels could be adapted to use by farmers in the United States. Among these are plans for portable milking houses, an inexpensive mechanical feeder-waterer for caged layers, handling of manure as a liquid, a toe space feature for the front edge of concrete pig troughs, effective tie-chains for dairy cattle, and a home-made method of bending corrugated aluminum sheets to make a smooth bend without breaking or crumpling the corrugations at the bend.

New Building Plans

Plans for four new farm structures are now available from county agents or extension agricultural engineers at most state agricultural colleges. USDA Plan No. 5772 illustrates a 14-head cattle hay rack. Plan No. 5778 is for a cattle holding chute with headgates. A 39 x 60-foot pole building is described in Plan No. 5830. Plan No. 5768 is for a 40 x 50-foot skid-mounted calf creep feeder.

EVENTS CALENDAR

April 22-24 — The 23rd annual *National Farm Chemurgic Conference,* Congress Hotel, Chicago, Ill. Contact the Council for Agricultural and Chemurgic Research, 350 Fifth Ave., New York 1, N. Y., for further details.

May 5-7 — Thirteenth *Purdue Industrial Waste Conference,* Purdue Memorial Union Building, Purdue University, Lafayette, Ind. Registration blanks will be mailed upon request to D. E. Bloodgood, School of Civil Engineering, Purdue University, Lafayette, Ind.

May 19 — A regional meeting of *Engineers Joint Council,* sponsored locally by the Western Society of Engineers, will be held at the Sherman Hotel in Chicago, Ill. For further information contact either Engineers Joint Council, 29 W. 39th St., New York 18, N. Y., or Western Society of Engineers, 84 E. Randolph St., Chicago 1, Ill.

June 11-14 — Annual meeting of the *National Society of Professional Engineers* in the Chase-Park Plaza Hotel at St. Louis, Mo. For further information write Kenneth E. Trombley, National Society of Professional Engineers, 2029 K St., N.W., Washington 6, D.C.

June 17-20 — Joint meeting of the *American Grassland Council* and the *American Dairy Science Association,* Raleigh, N. C. For further information write to Z. W. Craine, Sec'y-Treas., American Grassland Council, P.O. Box 30, Norwich, N. Y.

(Continued on page 256)

For more facts circle No. 57 on reply card

PERSONNEL SERVICE BULLETIN

PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin, the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this Bulletin, request form for Personnel Service listings.

POSITIONS OPEN — 1957 — OCTOBER — O-314-755. NOVEMBER — O-360-758, 379-761, 380-762. DECEMBER — O-385-763, 386-764, 387-765, 412-766, 370-767. 1958—JANUARY—O-436-768, 478-769. FEBRUARY — O-12-801, 48-803. MARCH — O-37-804, 72-805, 78-806, 83-807

POSITIONS WANTED — 1957 — OCTOBER — W-341-40, 301-41, 297-42. NOVEMBER—W-337-43, 320-44, 344-45, 356-47, 357-48, 342-49, 291-50, 363-51. DECEMBER—W-371-52, 378-53, 394-54, 405-55, 409-56, 415-57. 1958—JANUARY—W-447-58, 410-59, 381-60, 466-61, 484-62 485-63, 3-1, 4-2. FEBRUARY — W-21-4, 31-5, 33-6. MARCH—W-54-7, 36-8, 62-9, 46-10, 74-11, 80-12.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEER, instructor to associate professor rating, for research on machines, processes and procedures to lower labor requirements in tobacco production at an eastern university. Part time teaching optional. Field work within 50-mile radius. BSAE or ME. MS desirable. Familiar with machine design, construction and testing. Interest in research. US citizenship necessary before tenure can be given. Permanent appointment. Advancement based on accomplishment. Opening effective June 16. Salary open. O-70-808

AGRICULTURAL ENGINEER, instructor to associate professor rating, for teaching and research in agricultural mechanics, including shop practice, farm power, machinery and structures with a university in the Mediterranean area. MSAE with major in farm machinery preferred. BSAE considered at instructor level. Mature man preferred. Farm background and 4 or more years experience in teaching, research or industry. Usual personal qualifications for college work. Live on university farm and take general responsibility for equipment on the farm. Free housing. Travel allowance for appointee and immediate family. Educational benefits for children. Income tax saving. Free medical service. Pension plan. Salary \$5500-\$8000. O-97-809

AGRICULTURAL ENGINEER, graduate research assistant, for work in power and machinery, processing, or materials handling, at an eastern university. BSAE or equivalent with junior and senior grade point average of 2.8 or higher. Interest in research and desire to earn MS degree. Duty 11 months, vacation one month. Opening effective July 1 or September 1. Salary \$2800-\$3000 and tuition. O-122-811

AGRICULTURAL or CIVIL ENGINEER for research on quality of water in farm ponds, and effect of treatment on quality, at a midwestern state university. BSAE or CE. Some research experience preferred, but not essential. Usual personal qualifications for engineering research in public service. Able to handle contact with farmers and considerable field work. Can take full-time graduate work in Winter Quarter. Salary \$4688. O-121-812

PROJECT ENGINEER for design and development of diesel engines for wheel tractor application, with established manufacturer in Midwest. Prefer man with degree in engineering. Approximately 8 years or more experience on diesel engine design and development. Good character, energetic, dependable and capable of supervising others on design work. Excellent opportunity for right man. Salary open. O-120-813

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER for design, development, research or management training program in power and machinery or soil and water field, with industry. Any location. Willing to travel. Married. Age 25. No disability. BSAE, 1955, University of Missouri. Farm background. Summer work experience as tractor operator, truck driver, welder and mechanics helper. Completed engineer equipment maintenance officers course in Marine Corps and supervised operation and maintenance of earthmoving equipment. Three years commissioned service. Available June 1. Salary open. W-47-13

BUSINESSMAN for sales or service in power and machinery or agricultural credit with manufacturer, distributor, consultant, or agricultural credit organization. Anywhere in United States. Married. Age 36. No disability. BS in industrial administration, 1948, Oregon State College. Co-manager of family ranch, a 1000-acre livestock, hay and grain operation, 1948-56. Since 1956, assistant secretary-treasurer of a production credit association handling over \$4 million volume in 1957. War enlisted service in Navy. Available June 1. Salary \$6000 minimum. W-77-14

AGRICULTURAL ENGINEER for extension, teaching, research, sales, service, or writing in power and machinery field with industry or public service, anywhere in USA. Married. Age 37. No disability. BSA, 1947; BSME, 1948, University of Wisconsin. Farm background. Enlisted and commissioned war service in Army Corps of Engineers, general construction units, over 3 years. Teaching 9 years in agricultural and technical institute, including farm power, farm mechanics, farm buildings, farm shop, agricultural mathematics and rural engineering. Available September 1. Salary \$7500 minimum. W-98-15

AGRICULTURAL ENGINEER for research or teaching in farm product processing field with college or experiment station anywhere in USA. Married. Age 27. No disability. BSAE, 1953, National Taiwan University. MSAE, 1956, PhD expected 1958, Michigan State University. Teaching assistant 1½ years. Full time research associate over one year. Available in September. Salary open. W-102-16

(Continued on page 254)

This new OLIVER wins the baling race

It's in the rough fields, on the curving windrows and sharp corners that an Oliver outbales all others in its class.

Oliver's new models—the 60-T twine and 60-W wire—give you exclusive, "pivot-balanced" PTO drive, a short-coupled shaft that permits the rear tractor wheel to be cramped right against the bale case without breaking power. Your new Oliver baler is close on your tractor's heels. You merely stick with the windrow as it snakes around. No need to slow down, or swing way out to pick up a corner.

Here's full-speed baling *all the time.* Here's 10-ton-per-hour capacity in *any* field—hilly, odd-shaped, obstruction-filled. Here's the machine that saves time when it counts the most, that puts more quality into your hay crop by getting it into bales sooner.

A new, leaf-saving pickup packs more nutrients into every bale. A new, positive auger drive handles the heaviest bunches without a stutter. A new knife guide eliminates tails, gives you neat, sliced, easy-to-feed bales. See the new capacity champions in their bright, new colors of clover white and meadow green. The OLIVER Corporation, 400 W. Madison St., Chicago 6, Ill.

OLIVER

"FINEST IN FARM MACHINERY"

For more facts circle No. 58 on reply card

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Chamorro, Emilio, Jr.—Mgr., E. Chamorro Benard, Apartado 29, Granada, Nicaragua, C. A.

Colombino, Alfredo A. — Ingeniero agronomo, Technical Dept., T.A.Y.A. (Mail) Juan M. Gutierrez 2736 5° C, Buenos Aires, Argentina, S.A.

Eaton, Edward O. — Asst. prof., New York State College of Agriculture, Riley-Robb Hall, Cornell University, Ithaca, New York

Gupta, Rajendra K. — Graduate asst., agr. eng. dept., Pennsylvania State University, University Park, Pa.

Ivey, Robert O. — Service supervisor, International Harvester Co. (Mail) P.O. Box 6056, Jacksonville 5, Fla.

Martin, T. V. — Sales rep., Winamac Steel Products, Inc., Winamac, Ind.

Miller, Raymond J. — Chief engr., product eng. office, Tractor & Implement Div., Ford Motor Co., 2500 E. Maple Rd., Birmingham, Mich.

Mott, Richard H. — Engr., J. I. Case Co., Racine, Wis. (Mail) 1460 Ellis Ave.

Murdaugh, J. P. Jr. — Sales mgr., Race and Race, Inc. (Mail) 115 Lake Silver Dr., Winterhaven, Fla.

Neff, Earl L. — Proj. supervisor (ARS), USDA (Mail) P.O. Box 414, University Station, Moscow, Idaho

Oglesby, Leslie E.—Sales prom. supervisor, International Harvester Co. (Mail) 7261 Coligny Road, Jacksonville, Fla.

Perold, Louis—Product engr., South African Farm Implement Mfg., Ltd. (Mail) 75 Ring Road, Three Rivers, Vereeniging, South Africa

Poulsom, Daniel P. — Southern reg. engr., International Harvester Co. (Mail) 1986 W. Beaver St., P.O. Box 869, Jacksonville, Fla.

Slotten, Russell H. — Tour of duty, U.S. Army, B Btry., 502nd AAA Bn., APO 937, Seattle, Wash.

Sood, U. C. — Agr. engr., Solan (H. P.), India

Thomas, David R. — Proj. engr., A. Epstein & Sons, Inc. (Mail) 1521 Forest Ave., Wilmette, Ill.

Van Duyne, Giles O. — Mgr., Linder Irrigation Div., Linder Ind. Eng. Co., P.O. Box 2037, Lakeland, Fla.

Vaughn, Charles C. — Civil engr., (SCS), USDA (Mail) 410 Belle Claire Dr., Columbia, S. C.

TRANSFER OF MEMBERSHIP

Blanchard, Bruce J. — Owner, mgr., Blanchard Implement Co., P.O. Box 815, Guthrie, Okla. (Associate Member to Member)

Carpenter, Harold E.—Self employed, R.R. 1, Oliver Springs, Tenn. (Associate Member to Member)

Converse, Harry H. — Agr. engr., (AMS, MRD), USDA (Mail) P.O. Box 192, Eskridge, Kans. (Associate Member to Member)

Shimon, Donald F. — Chief prod. engr., Butler Mfg. Co. (Mail) 3316 Norton Ave., Independence, Mo. (Associate Member to Member)

Smith, Easley, S. — Asst. ext. agr. engr., Virginia Polytechnic Institute (Mail) 111 Overlook Drive, Blacksburg, Va. (Associate Member to Member)

Vorster, Pieter J. C. — Head, Dept. of Agr. Eng., University of Natal (Mail) Pte. Bag 1021, Pietermaritzburg, South Africa. (Associate Member to Member)

. . . Personnel Service

(Continued from page 252)

AGRICULTURAL ENGINEER for design, development, and construction in soil and water field, with consultant, in West or foreign assignment. Willing to travel. Married. Age 23. No disability. BSA and BSCE expected in June, University of Wisconsin. Farm operation and outside farm employment while in high school. College student and summer vacation work experience as spot-welder, dairy worker, assistant project engineer in irrigation engineering, salesman, and general business office work. Available in June. Salary open. W-107-17

AGRICULTURAL ENGINEER for development, research, or management in power and machinery, farm structures, or soil and water field with federal agency, consultant, farming operation, or trade association, in Midwest or South America. Married. Age 23. No disability. BSAE, 1956, North Dakota Agricultural College. Farm background. SCS experience over 6 months in charge of survey crews, calculating cost estimates and designing earthfill dams for watershed planning party. Active commissioned service in Army Anti-Aircraft Artillery since February 1957. Available April, 1959. Salary $6000. W-94-18

FARM MECHANICS graduate for extension, sales, or service in power and machinery or rural electric field, with distributor preferably on West Coast. Married. Age 23. No disability. BS in mechanized agriculture expected in June, North Carolina State College. Farm background. Army enlisted service 2 years with electronics training and experience in training operators and supervising maintenance of long range radar. Available July 1. Salary open. W-106-19

The following bulletins have been released recently. Copies may be obtained by writing to author or institution listed with each.

Hungarian Technical Abstracts, Vol. 9, No. 2, a quarterly bulletin published by the National Technical Library in English, Russian and German. For further information write to the editorial office of Hungarian Technical Abstracts, P.O. Box 12, Budapest 8, Hungary.

Traction Problems with Mounted Tillage Implements, by J. G. Kemp and J. L. Thompson, Publication 999, January 1957. *A Miniature Forage Crop Harvester,* by J. G. Kemp and W. J. Pigden, reprinted from Canadian Journal of Agricultural Science 36:505-507, November-December 1956. Two publications available on request to the Agricultural Engineering Section, Central Experimental Farm, Department of Agriculture, Ottawa, Ontario, Canada.

Bulk Tank Milk Storage, by J. B. Brooks, J. D. Foster and E. C. Scheidenhelm, Circular 553. University of Kentucky, College of Agriculture and Home Economics, Agricultural Extension Service, Lexington.

List of Publications and Motion Picture Films, Circular No. 3, 1957 edition. St. Anthony Falls Hydraulic Laboratory, Mississippi River at 3rd Ave., S.E., Minneapolis 14, Minn.

Conveyor Feeding System for Dairy Cows in Stanchions and in Loose Housing, by E. C. Schneider. Progress Report No. 2, Bulletin 605, December 1957. Agricultural Experiment Station, University of Vermont, Burlington, Vt.

Wet Sieving Apparatus for Stability of Soil Aggregates, by S. J. Bourget and J. G. Kemp. Reprinted from Canadian Journal of Soil Science 37:60, February 1957. Central Experimental Farm, Ottawa, Ontario, Can.

North Carolina's Farm Structures, by Blaine F. Parker. Information Circular No. 13, July 1957. Agricultural Experiment Station, North Carolina State College, Raleigh, N. C.

Leader Training for Aided Self-Help Housing, by Keith H. Hinchcliff, University of Illinois, Urbana, Ill.

Economical and Technical Aspects of Sprinkler Irrigation in the United States, by Herman Bouwer, Alabama Polytechnic Institute, Auburn, Ala.

Aeration of Grain in Commercial Storages, compiled by Leo E. Holman. Marketing Research Report No. 178, September 1957. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price 35 cents.

Nailing of Subflooring, with supplement on Effectiveness of Square Barbed versus Threaded Bronze Nails in Redwood, by E. George Stern. Bulletin 57051400, No. 31, September 1957. Wood Research Laboratory, Virginia Polytechnic Institute, Blacksburg, Va.

Irrigation Turbine Pump Drives, by D. E. Lane, P. E. Fischbach and H. R. Mulliner. E. C. 57-701, August 1957. For further details write to P. E. Schleusener, Agricultural Engineering Dept., University of Nebraska, Lincoln 3, Nebr.

. . . Events Calendar

(Continued from page 250)

June 23-27—Twelfth technical *Photographic Exhibit* of the American Society for Testing Materials, Hotel Statler, Boston, Mass. Further information may be obtained from E. W. Walsh, chairman, ASTM Photographic Exhibit, the Narragansett Electric Co., 15 Westminster St., Providence, R. I., or the Headquarters of the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

June 29-July 11 — *Short Courses on Materials Engineering Design for High Temperature* at Pennsylvania State University to keep design engineers and others engaged in research on materials abreast of new development in the field. For further details contact Joseph Marin, Engineering Mechanics Dept., Pennsylvania State University, University Park, Pa.

August 12-14 — *Cotton Production and Mechanization Conference,* Brownsville, Texas. Details may be obtained by writing Farm Equipment Institute, 608 S. Dearborn St., Chicago 5, Ill.

September 17-19—*Farm Materials Handling Conference,* Iowa State College, Ames, sponsored by American Society of Agricultural Engineers. For further details see page 130, March 1958 issue of AGRICULTURAL ENGINEERING, or write ASAE, 420 Main St., St. Joseph, Mich.

September 29 to October 4 — *Fifth International Congress of Agricultural Engineering* to be held in Brussels, Belgium. The aim is to stimulate the science and the techniques of agricultural engineering, as well as the use of these techniques; and to coordinate scientific research and techniques in the fields related to agricultural engineering. Registration information may be obtained by writing to M. Nestor Laret, Avenue des Combattants, 69, Gembloux, Belgium.

May 29-June 7, 1959 — *RiLa* arranged by Swedish Federation of County Agricultural Societies and billed to be the largest agricultural show to be held in Sweden since 1946. Its aim is to give presentation of Sweden's mechanized farming and high-quality livestock breeding, and also the country's agriculture as an export-import industry. Further details may be obtained from The Swedish-International Press Bureau, Brunkebergstorg 14, Stockholm, Sweden.

Index to Advertisers

ADVERTISING REPRESENTATIVES

New York 17 — BILLINGSLEA AND FICKE, 420 Lexington Ave. LExington 2-3667

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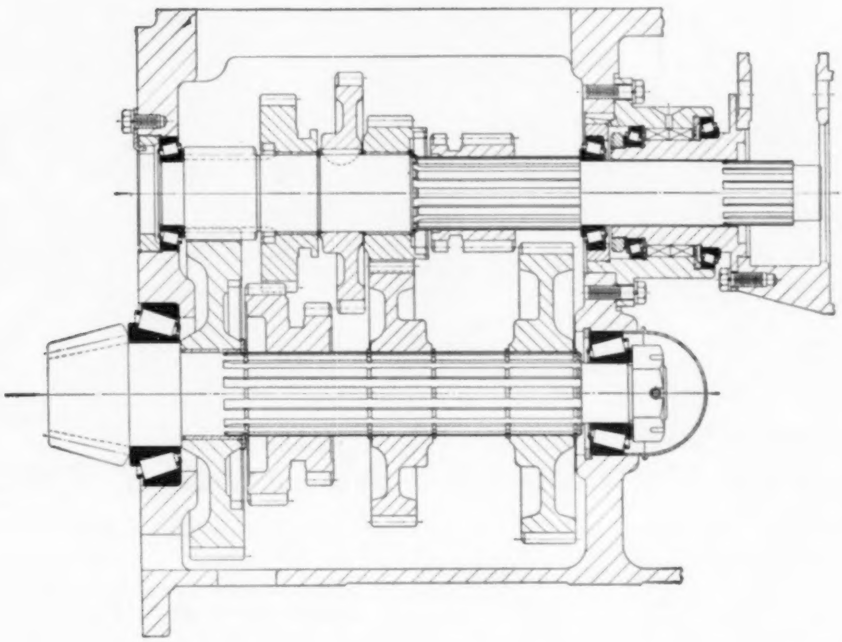
Highest capacity at lowest cost in new Minneapolis-Moline tractor transmission

Timken® bearings simplify gear reduction unit, give greater rigidity for longer life



WITH a simpler design, Minneapolis-Moline engineers achieved high capacity for the transmission of their new MM 5-Star tractor. And they did it at lowest possible cost by using Timken® tapered roller bearings in the gear reduction unit.

Using Timken bearings enabled them to apply the effective spread principle at the bevel pinion. The design of the bearing at this point is such that the effective center of the bearing's load-carrying capacity is close to the bevel pinion center line, providing the ultimate in rigidity at this vital point. Throughout the transmission, Timken bearings assure maximum rigidity, keep all gears in alignment under rugged farm working conditions. No other bearings can give equal capacity at the price.

Simpler and more compact designs are big reasons why more and more engineers are standardizing on Timken bearings for rugged farm machinery. Full-line contact between rollers and races gives Timken bearings extra load-carrying capacity. Timken bearings keep shafts concentric with their housings—make closures more effective. Dirt stays out; lubricant stays in. And because Timken bearings practically eliminate friction, they save power and cut fuel consumption.

Agricultural engineers find answers to three big problems with Timken tapered roller bearings: 1) Combination loads; 2) dirt; 3) ease of operation. Timken bearings are a precision product—both by design and manufacture. We even make our own steel. No other American bearing manufacturer does.

For help in designing new bearing applications, contact our sales engineers or write to The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable: "TIMROSCO".

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